SOIL SURVEY OF

JOHNSON COUNTY, MISSOURI

United States Department of Agriculture
Soil Conservation Service,
in cooperation with
Missouri Agricultural Experiment Station

How To Use This Soil Survey

General Soil Map

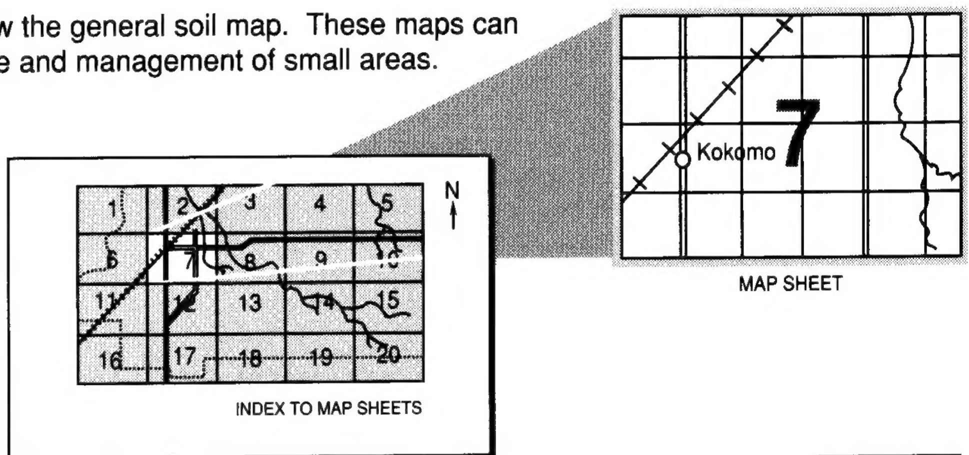
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

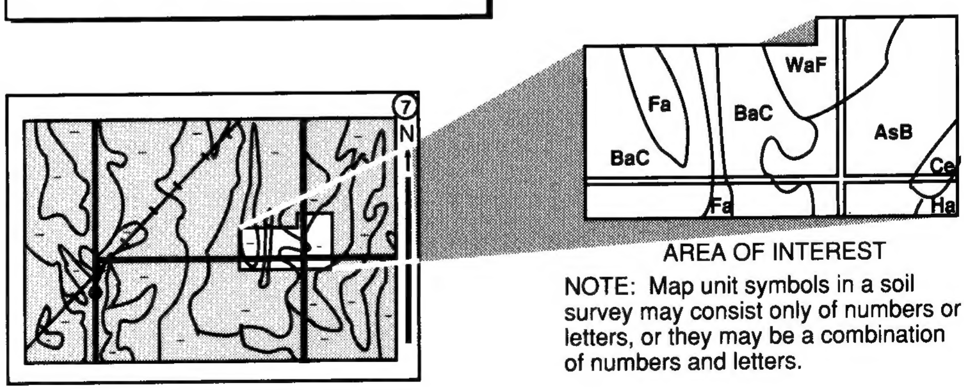
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1972-1976. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1977. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. It is part of the technical assistance furnished to the Johnson County Soil and Water Conservation District, which provided personnel who assisted with fieldwork.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Typical landscape of mixed crops and pasture. Zook silty clay loam is in the foreground, and Sampsel, Snead, and Polo soils are in the background.

Contents

Issued February 1980

Index to map units

Summary of tables

Summary of tables—Continued

Foreword

This soil survey contains information that can be used in land-planning programs in Johnson County, Missouri. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

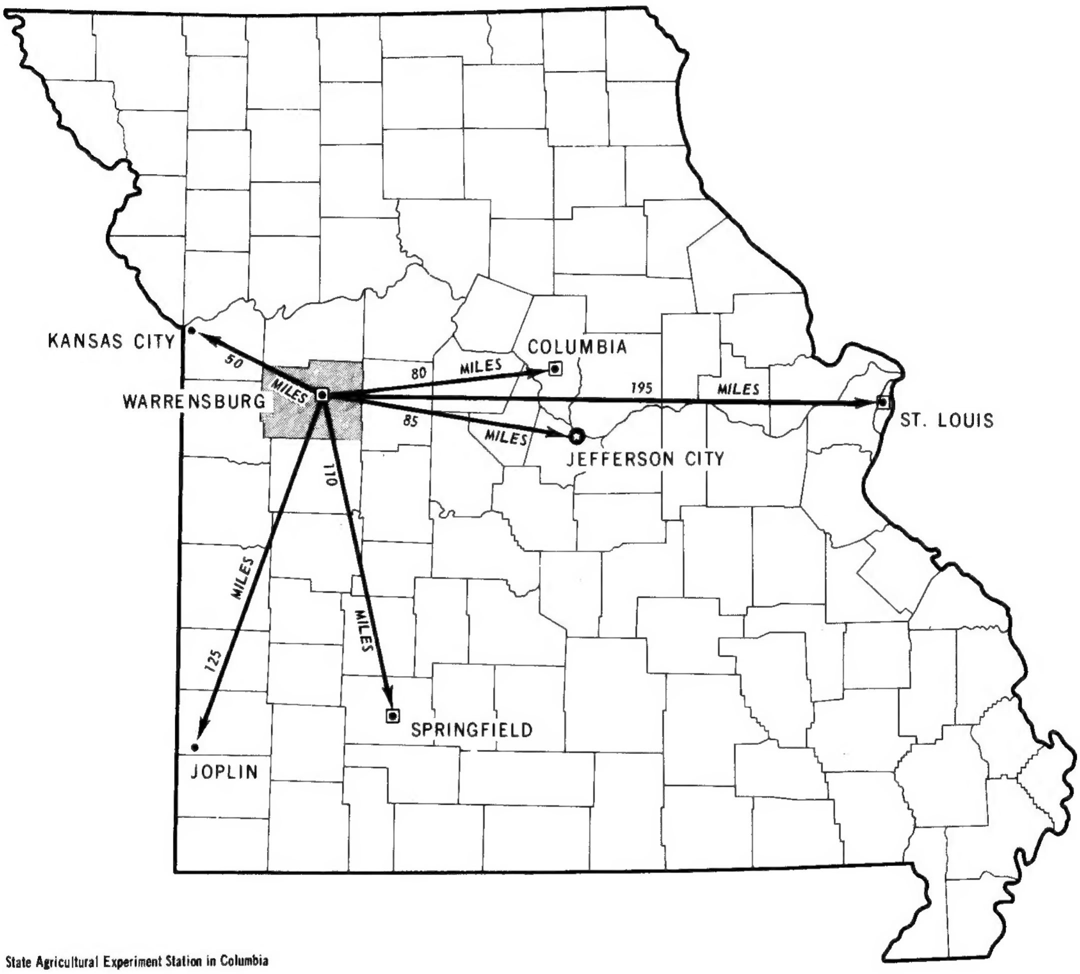
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Kenneth G. McManus

Kenneth G. McManus
State Conservationist
Soil Conservation Service



Location of Johnson County in Missouri.

SOIL SURVEY OF JOHNSON COUNTY, MISSOURI

By George T. Simmons, Soil Conservation Service

Fieldwork by George T. Simmons, Frederick E. Horn, and Michael A. McGrew, Soil Conservation Service, and Richard E. McBee and John D. Preston, Johnson County Soil and Water Conservation District

United States Department of Agriculture, Soil Conservation Service, in cooperation with Missouri Agricultural Experiment Station

JOHNSON COUNTY is in the west-central part of Missouri. Warrensburg, the county seat, has a population of 13,125 and is located near the center of the county. The county has a total area of 528,640 acres or 826 square miles. Farming is the main enterprise of Johnson County. The principal field crops are corn, soybeans, legumes, and grasses. Beef cattle is the largest livestock enterprise, however, there are also hogs, dairy cattle, and sheep.

The county is in the Cherokee Prairie Land Resource Area of the Central Feed Grains and Livestock Region of the United States (*3*). The Blackwater River is the largest stream in the county. It has cut a valley that extends in an east-west direction through the center of the county. Most of the county consists of the Blackwater River Valley and undulating to rolling uplands. Big Creek has cut a valley across the southwest corner of the county. A small part of the county drains into Big Creek. Elevation ranges from about 650 feet in the northeast corner, where the Blackwater River leaves the county, to about 1,080 feet in the northwest corner.

General nature of the county

This section discusses, in general, how the land is used, and, in more detail, farming; physiography and drainage; and climate.

Natural resources

Soil is the most important natural resource in the county. Crops produced on farms and livestock that graze the grassland are dependent on the soil.

In most of the county, water is adequate for domestic use and for watering livestock. The underground geologic formation of Roubidoux Sandstone is an important water bearing source for deep wells (*16*). Wells that are 700 to 1,000 feet deep supply water to towns south and east of Warrensburg. Deep wells north and west of Warrensburg are considered to be mineralized and are below acceptable drinking water standards of the U.S. Public Health Service. Some parts of the county are irrigated. Shallow lakes are a source of this water.

Coal deposits are extensive throughout Johnson County. Most mining took place in the southeastern part of the county, where the coal veins are close enough to the surface for strip mining operations. In the rest of the county, however, the deep shaft method was used in the early mines. Today very little coal is mined. Coal seams lie from 45 to 120 feet below the surface and range from 18 to 40 inches in thickness. Limestone is quarried in limited amounts, mainly for farming uses and for road material.

Farming

The first settlers in Johnson County located along small streams which were bordered on both sides by forested areas that ranged from 1 mile to 3 miles in width. The settlers cleared a few acres of land, using the timber for fuel, fence posts, and the construction of log cabins. Because they thought breaking the turf of the prairie land was impossible, it was used for rangeland. Few of the settlers attempted to cultivate more than a few acres, which was used for growing corn and vegetables for food.

Corn soon became the principal crop; although wheat, flax, oats, and rye received early attention, and some tobacco and hemp were grown. The county developed rapidly until the Civil War, which arrested agricultural progress.

The extensive rangelands of the county made the raising of livestock profitable. In later years, corn growing was expanded, but the crop was difficult to sell. Then, the feeding of hogs and cattle for market was undertaken and developed rapidly into a profitable industry. The combination of livestock industry and grain production is

the prevailing type of agriculture in the county at the present time.

The enactment of the Soil Conservation District legislation in 1937 stirred the interest of many landowners in Johnson County. The Johnson County Soil and Water Conservation District was organized on March 11, 1944, and was the eleventh Soil Conservation district in Missouri.

About 2,016 farms have an average of 223 acres. Approximately 90 percent of the land is owner operated. The farms fall into the following categories: Livestock—45 percent, part-time residential—36 percent, cash grain—11 percent, dairying—7 percent, and poultry—1 percent. Approximately 58 percent is cropland, 25 percent is grassland, 15 percent is woodland, and 2 percent is other land.

Settlement and population

Johnson County was originally a part of Lillard County, which made up much of the west-central part of the state. Johnson County was organized in 1834. The first settlers arrived in 1828. They settled in Columbus, the first county seat of Johnson County. Warrensburg was settled in 1832 and became the county seat in 1836 (*11*).

Settlement progressed slowly at first. Lexington, on the Missouri River, was the supply center. Conflicts with Indians and Civil War strife slowed settlement until about 1870. Afterwards, the population and farming increased rapidly. Coal mining became an important industry, and some mines were worked until after 1940 (*11*).

According to the census, Johnson County had a population of 24,899 in 1920, reached a low of 20,716 in 1950, and increased to 34,172 in 1970. Warrensburg, the largest town, had a population of 4,811 in 1920, 6,857 in 1950, and 13,127 in 1970.

Population trends show an increase from 1828, when the first settlers arrived, until about 1920. The rural people started migrating to the cities, and the population of Johnson County decreased until after 1950. At this time, many of the people working in the Kansas City area bought hobby farms in Johnson County, where they lived and commuted to work in Kansas City. This caused a general population increase in both rural areas and towns.

Climate

The consistent pattern of climate in Johnson County is one of cold winters and long, hot summers. Heavy rains occur mainly in spring and early in summer, when moist air from the Gulf of Mexico interacts with drier continental air. Even though the annual rainfall is normally adequate for corn, soybeans, and all grain crops in most years, yields are reduced because of the absence of rain during July and August.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Warrensburg, Missouri, for the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 34 degrees F, and the average daily minimum temperature is 25 degrees. The lowest temperature on record, -13 degrees, occurred at Warrensburg on January 7, 1968. In summer, the average temperature is 78 degrees, and the average daily maximum is 89 degrees. The highest temperature, 116 degrees, was recorded on July 14, 1954.

Growing degree days, shown in Table 1, are equivalent to "heat units." Beginning in spring, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 26 inches, or 67 percent, usually falls during the period April through September, which includes the growing season for most crops. Two years in ten, the April-September rainfall is less than 19 inches. The heaviest 1-day rainfall during the period of record was 5.92 inches at Warrensburg on July 20, 1965. Thunderstorms number about 47 each year, 20 of which occur in summer.

Average seasonal snowfall is 16 inches. The greatest snow depth at any one time during the period of record was 15 inches. On the average, 8 days have at least 1 inch of snow on the ground, but the number of days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night in all seasons, and the average at dawn is about 80 percent. The percentage of possible sunshine is 75 percent in summer and 65 percent in winter. The prevailing direction of the wind is from the south-southwest. Average windspeed is highest, 12 miles per hour, in February.

Tornadoes and severe thunderstorms occur occasionally but are local and of short duration. Damage varies and is spotty. Hailstorms occur at times during the warmer part of the year but in an irregular pattern and in only small areas.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent

material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The soils in the survey area vary widely in their potential for major land uses. Table 4 shows the extent of the map units shown on the general soil map. It lists the potential of each, in relation to that of the other map units, for major land uses and shows soil properties that limit use. Soil potential ratings are based on the practices commonly used in the survey area to overcome soil limitations. These ratings reflect the ease of overcoming the limitations. They also reflect the problems that will persist even if such practices are used.

Each map unit is rated for *cultivated crops, specialty crops, woodland, urban uses,* and *recreation areas*. Cultivated crops are those grown extensively in the survey area. Specialty crops are the vegetables and fruits that generally require intensive management. Woodland refers to areas of native or introduced trees. Urban uses include residential, commercial, and industrial developments. Intensive recreation areas are campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic. Extensive recreation areas are those used for nature study and as wilderness.

1. Macksburg-Sampsel association

Deep, gently sloping and moderately sloping, somewhat poorly drained soils that formed in loess and residuum from shale; on uplands

These soils are on broad divides that separate the major drainage systems of the county (fig. 1).

This association makes up about 8 percent of the county. About 50 percent is Macksburg soils, 30 percent is Sampsel soils, and 20 percent is soils of minor extent.

Macksburg soils are gently sloping, and Sampsel soils are gently sloping and moderately sloping. Macksburg soils formed in deep loess, and Sampsel soils formed in mixed loess and shale residuum. Macksburg soils are mainly on the higher, wider divides. Sampsel soils are on side slopes.

Macksburg soils have a silt loam surface layer and a mottled silty clay loam subsoil and substratum. Sampsel soils have a silty clay loam surface layer, a mottled silty clay loam and silty clay subsoil, and a mottled silty clay substratum.

The soils of minor extent are Higginsville, Polo, Snead, Winfield, and Nodaway soils. Higginsville soils are on upper parts of side slopes. Polo soils are on narrow ridgetops and the upper parts of side slopes. Snead soils are on steeper side slopes. Winfield soils are on ridge points and the upper parts of side slopes where trees are the predominant vegetation. Nodaway soils are on small stream bottom lands.

The main types of farming are cash-grain, livestock, and dairy (fig. 2). Corn, soybeans, small grain, and grass for hay and pasture are the principal crops. Because these soils are nearly level to sloping on long slopes, sheet erosion is a major hazard. Management that includes intensive erosion control practices is needed.

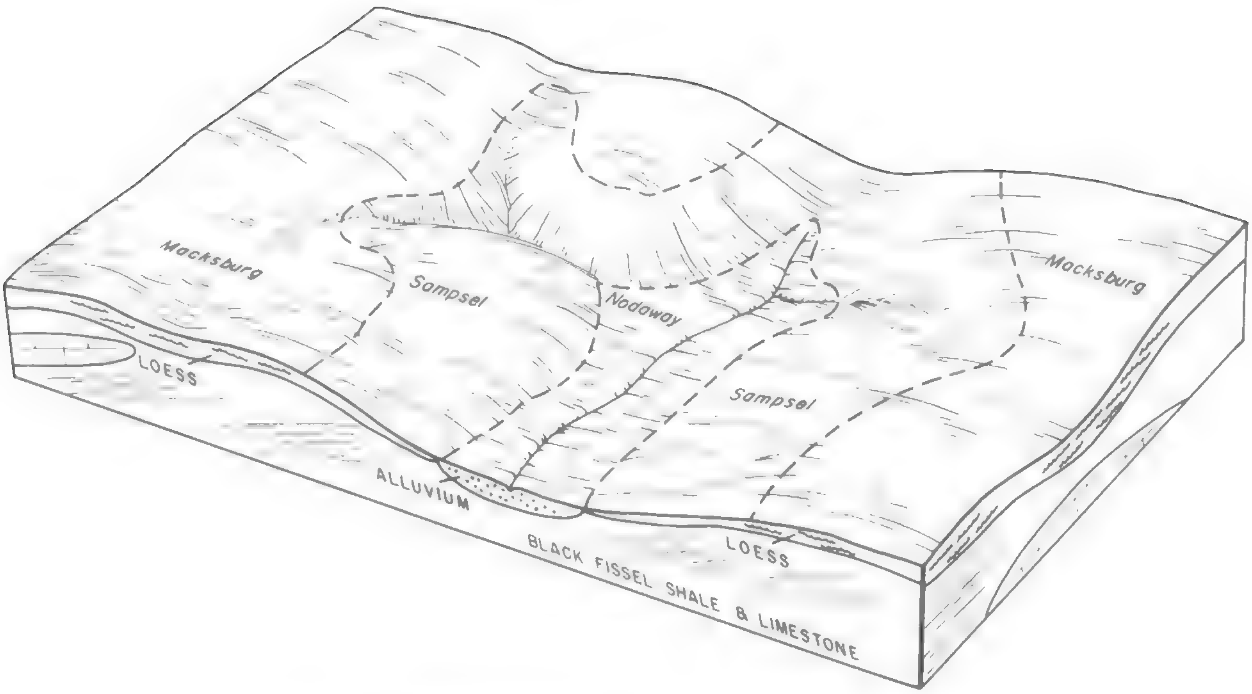


Figure 1.—Relationship of soils in the Macksburg-Sampsel association.

Figure 2.—Soybeans on Macksburg silt loam.

2. Sampsel-Snead-Polo association

Deep and moderately deep, gently sloping to steep, well drained to somewhat poorly drained soils that formed in loess and residuum from limestone and shale; on uplands

These soils are on gently sloping narrow ridgetops, moderately sloping upper parts of side slopes, and strongly sloping to steep lower parts of side slopes (fig. 3).

This association makes up about 26 percent of the county. About 30 percent is Sampsel soils, 26 percent is Snead soils, 17 percent is Polo soils, and 27 percent is soils of minor extent.

Sampsel soils are somewhat poorly drained, and they are on side slopes at the head of drainageways. Snead soils are moderately well drained, and they are on steeper side slopes where limestone and shale are near the surface. Polo soils are well drained, and they are on narrow ridgetops and the upper parts of side slopes.

Sampsel soils have a silty clay loam surface layer, a mottled silty clay loam and silty clay subsoil, and a mottled silty clay loam and silty clay substratum. Snead soils have a silty clay loam substratum mixed with soft shale. Polo soils have a silt loam surface layer and a silty clay loam subsoil.

The soils of minor extent are Deepwater, Gorin, Nodaway, and Winfield soils. These soils are in small tracts on uplands and on narrow bottom lands. Deepwater soils are on ridgetops and the upper parts of side slopes. Gorin soils are on side slopes. Nodaway soils are on narrow bottom lands. Winfield soils are on ridgetops and side slopes where trees are the dominant vegetation.

The main types of farming are livestock and field crops. Some areas are in woodland. Corn, soybeans, grain sorghum, small grain, and meadow and pasture plants are the principal crops. Because these soils are deep to moderately deep, silty and clayey, and gently sloping to strongly sloping, sheet erosion and gully erosion are major hazards. Management that includes varied and intensive erosion control practices is essential.

3. Mandeville-Norris-Bolivar association

Shallow and moderately deep, gently sloping to steep, well drained and moderately well drained soils that formed in residuum from sandstone and shale; on uplands

These soils are on gently sloping, narrow ridgetops, moderately sloping to strongly sloping upper parts of side slopes, and moderately steep to steep lower parts of side slopes (fig. 4).

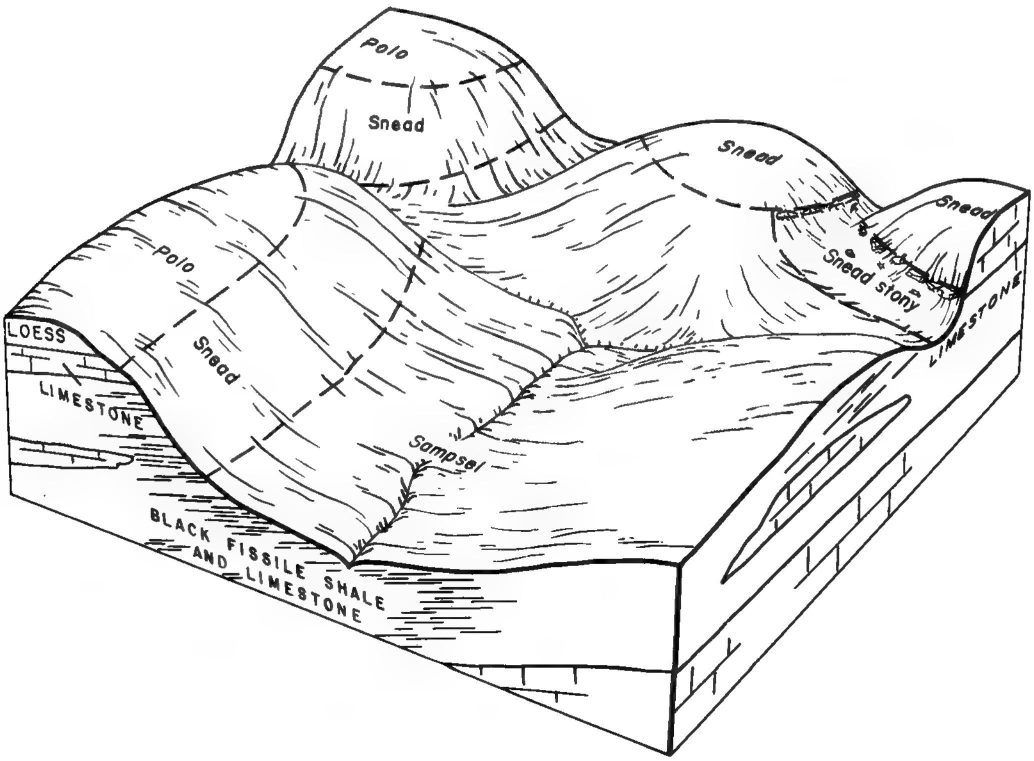


Figure 3.—Relationship of soils in the Sampsel-Snead-Polo association.

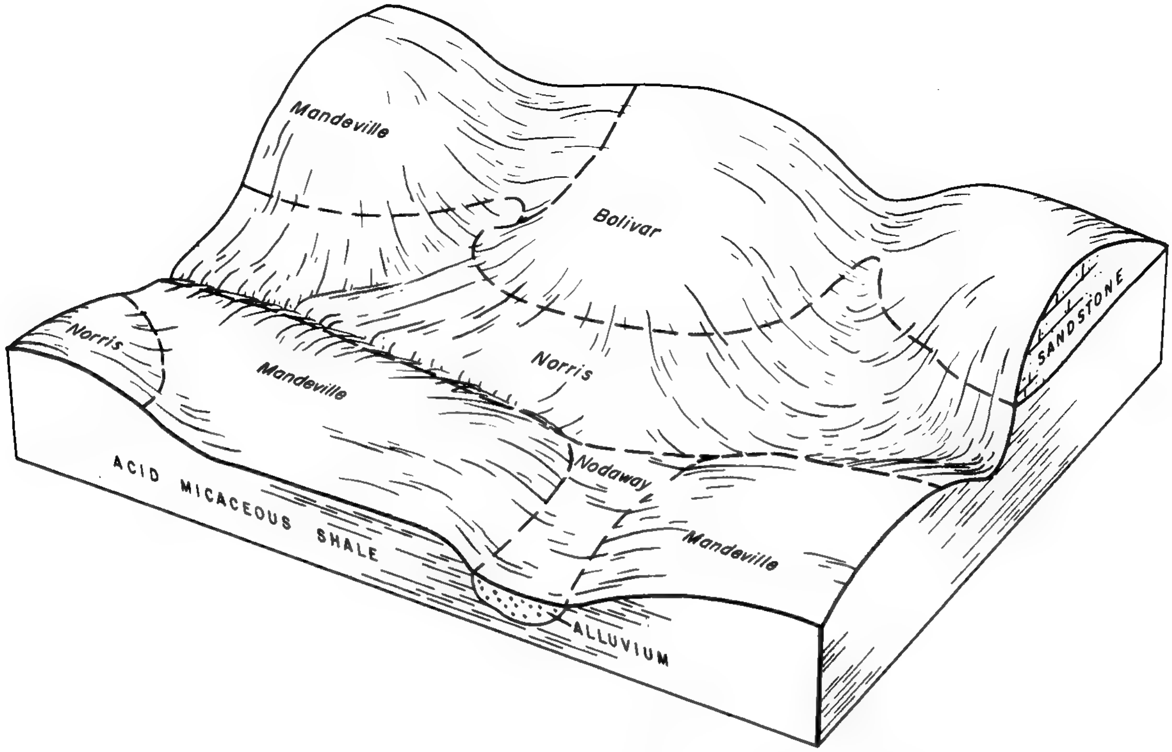


Figure 4.—Relationship of soils in the Mandeville-Norris-Bolivar association.

This asssociation makes up about 15 percent of the county. About 40 percent is Mandeville soils, 24 percent is Norris soils, 16 percent is Bolivar soils, and 20 percent is soils of minor extent.

Mandeville and Norris soils formed in silty residuum from shale. Mandeville soils are on narrow ridgetops and the upper parts of side slopes. Norris soils are on the steeper side slopes between Mandeville soils and stream bottoms. Bolivar soils are on side slopes where sandstone is present.

Mandeville soils have a silt loam surface layer and subsurface layer and a silty clay loam subsoil over shale. Norris soils have a shaly silt loam surface layer and subsoil over soft shale. Bolivar soils have a fine sandy loam or loam surface layer and subsurface layer and a loam or clay loam subsoil over weathered sandstone.

The soils of minor extent are Deepwater, Barco, Nodaway, and Weller soils. Barco, Deepwater, and Weller soils are on ridgetops and side slopes, and Nodaway soils are on narrow bottom lands.

The main type of farming is livestock. Grasses and legumes for hay and pasture are the principal crops. Corn, soybeans, and grain sorghum are grown in some areas. Some large areas where slopes are steep and soils are shallow remain in unimproved timber (fig. 5). Management that includes erosion control practices is essential.

4. Sampsel-Deepwater-Haig association

Deep, nearly level to moderately sloping, moderately well drained to poorly drained soils that formed mostly in loess and residuum from shale; on uplands

These soils are on old, stable ridgetops and the associated ridge points and side slopes (fig. 6).

This association makes up about 40 percent of the county. About 31 percent is Sampsel soils, 14 percent is Deepwater soils, 13 percent is Haig soils, and 42 percent is soils of minor extent.

Sampsel soils are on side slopes and narrow ridges, and they formed in thin loess and residuum from shale. Deepwater soils are on side slopes and ridge points, and they formed in residuum from shale. Haig soils are on the broad ridges, and they formed in loess.

Sampsel soils have a silty clay loam surface layer, a mottled silty clay loam and silty clay subsoil, and a mottled silty clay loam or silty clay substratum. Deepwater soils have a silt loam surface layer and a silty clay loam subsoil. Haig soils have a silt loam and silty clay loam surface layer and a silty clay loam and silty clay subsoil that is mottled in the lower part.

The soils of minor extent are Hartwell, Macksburg, Weller, Barco, and Snead soils. Hartwell soils are on broad ridgetops and upper parts of side slopes. Macks-

Figure 5.—Road through unimproved woodland on Norris soils in the foreground and Mandeville soils in the background.

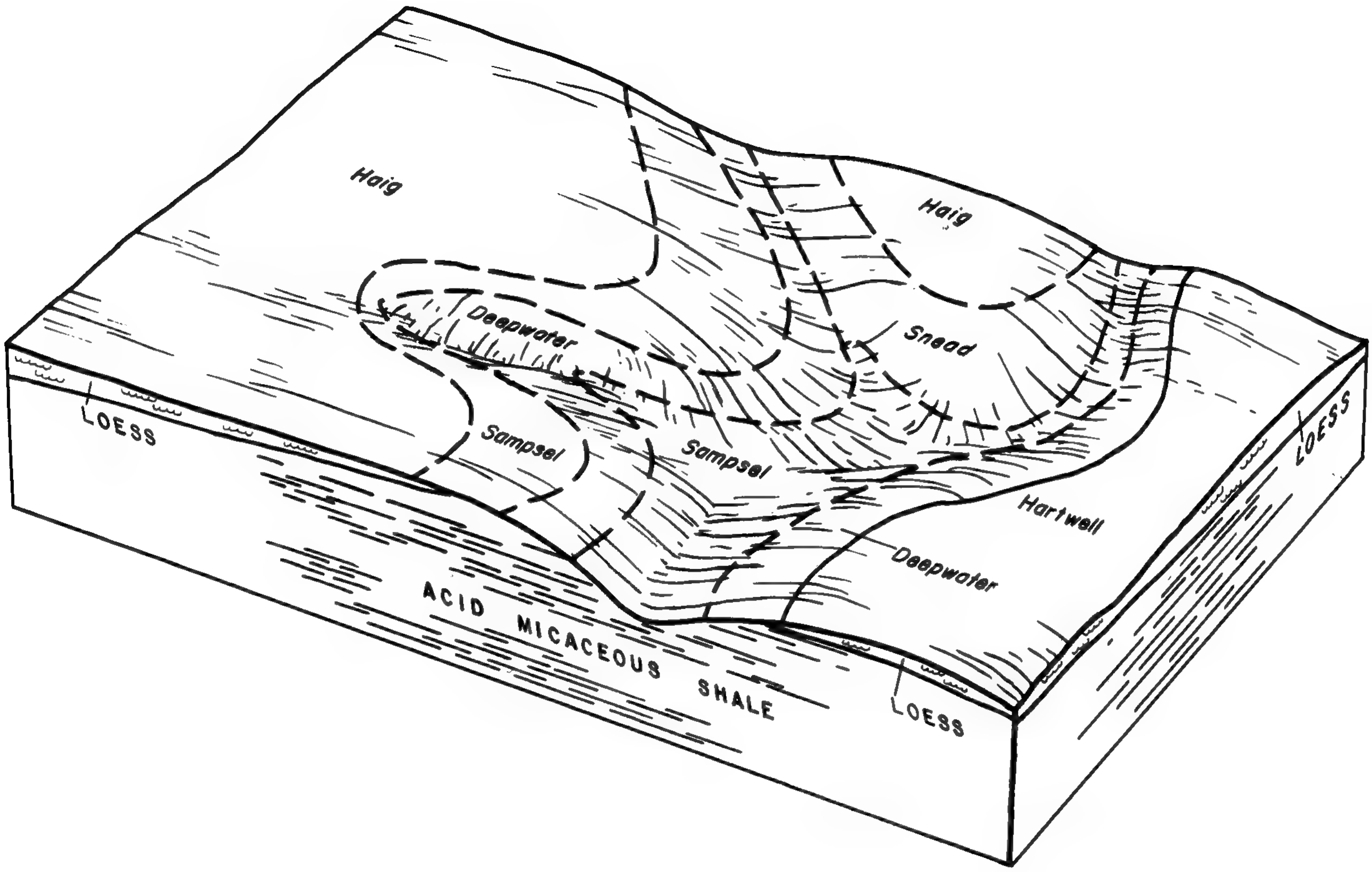


Figure 6.—Relationship of soils in the Sampsel-Deepwater-Haig association.

burg soils are on ridgetops. Weller soils are on narrow ridgetops where trees are the native vegetation. Barco soils are on ridgetops and side slopes where the residuum is sandstone. Snead soils are on side slopes.

The main types of farming are cash-grain, livestock, and dairy. Corn, soybeans, small grain, and grass for hay and pasture are the principal crops (fig. 7). Because these soils are nearly level to moderately sloping on long slopes, sheet erosion is the major hazard. Management that includes intensive erosion control is needed.

5. Zook-Dockery-Blackoar association

Deep, nearly level, somewhat poorly drained and poorly drained soils that formed in alluvium; on bottom land

These soils are on bottom lands of larger streams in the county (fig. 8).

This association makes up about 11 percent of the county. About 32 percent is Zook soils, 20 percent is Dockery soils, 17 percent is Blackoar soils, and 31 percent is soils of minor extent.

Zook soils formed in silty and clayey alluvium, commonly adjacent to the upland. Dockery and Blackoar soils formed in silty alluvium near present streams or previous channels where the streams have been straightened. Dockery soils are somewhat poorly drained, and Blackoar and Zook soils are poorly drained.

Zook soils have a silty clay loam surface layer and a silty clay subsoil. Dockery soils have a silty clay loam surface layer and stratified silty clay loam and silt loam underlying layers. Blackoar soils have a silt loam surface layer and a mottled silt loam subsoil and substratum.

The soils of minor extent are Nodaway, Bremer,

Figure 7.—Irrigated wheat and corn on Haig silt loam.

Wabash, Freeburg, and Lightning soils. Nodaway soils are near streams. Bremer, Freeburg, and Lightning soils are on second bottoms and terraces. Wabash soils are in depressional areas.

The main type of farming is cash-grain. Corn, soybeans, and sorghums are the principal crops. Grass for pasture and hay is grown in some areas. Wetness and flooding are limitations for farming and most other purposes. Flooding and ponding are common in winter and spring.

The potential for cultivated crops is good if the soils are adequately drained. Wetness is such a severe limitation and so difficult to overcome that the potential for residential and other urban uses is poor. The potential for wetland wildlife is good.

Broad land use considerations

Deciding which land should be used for urban development is an important issue in the survey area. Each year a considerable amount of land is developed for urban uses in Warrensburg and other cities in the county. The general soil map is most helpful for planning the general outline of urban areas; it cannot be used for the selection of sites for specific urban structures. In general, in the survey area the soils that have good potential for cultivated crops have fair potential for urban development. The data about specific soils in this survey can be helpful in planning future land use patterns.

Areas where the soils are so unfavorable that urban development is prohibitive are not extensive in the

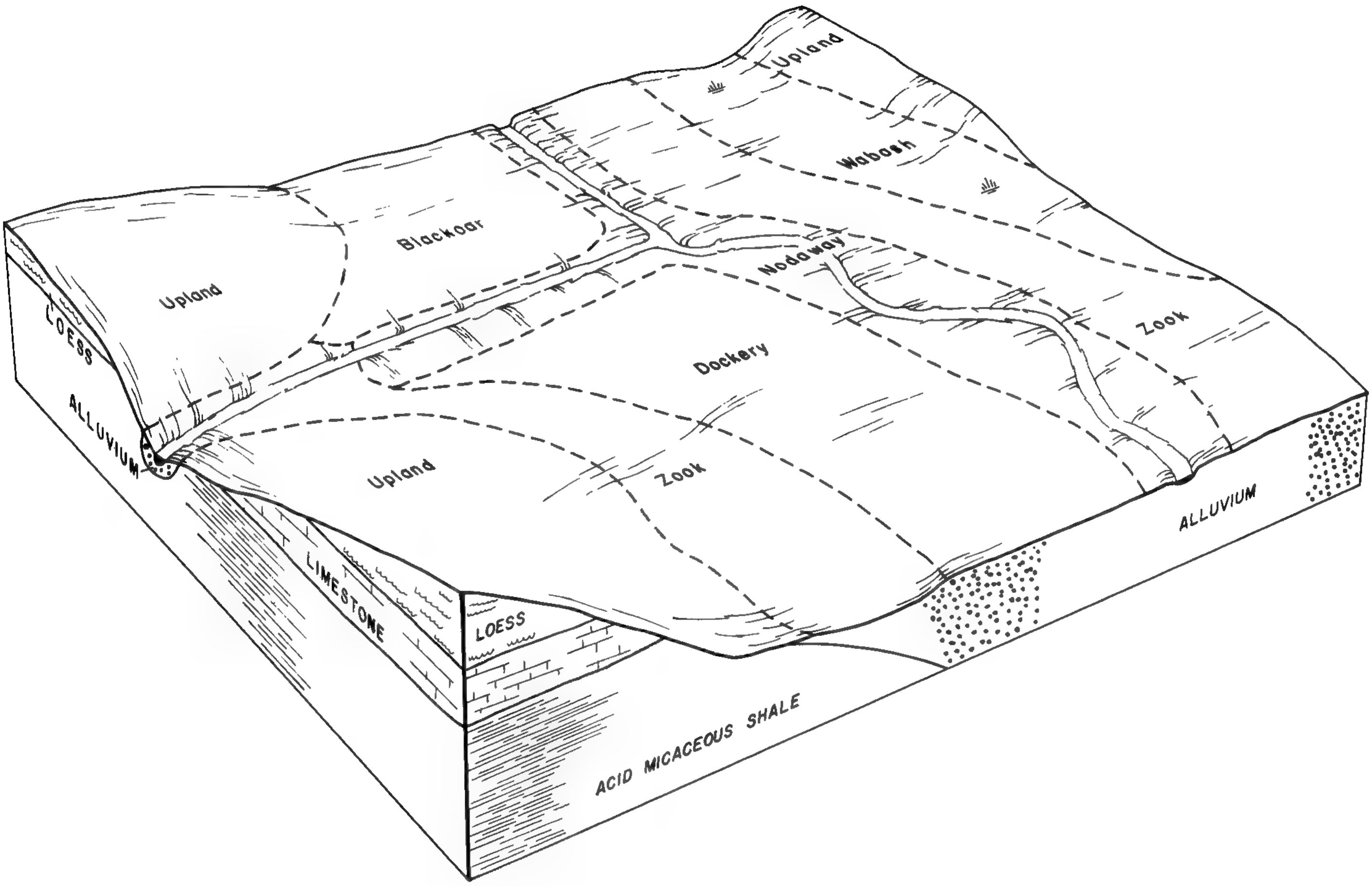


Figure 8.—Relationship of soils in the Zook-Dockery-Blackoar association.

survey area. Large areas of the Zook-Dockery-Blackoar association, however, are on flood plains in which flooding and low strength are severe limitations. Many parts of the Mandeville-Norris-Bolivar association and some parts of the Sampsel-Snead-Polo association are steep and have bedrock at the surface or a few feet below. Urban development is costly in these areas. Soils of the Sampsel-Deepwater-Haig association have poor potential for urban development because of wetness and high shrink-swell potential.

The soils in associations 1, 2, and 4, as identified on the general soil map, are excellent for the production of cultivated row crops. The soils in the Zook-Dockery-Blackoar association are also suited to the production of row crops if steps are taken to protect the soils from flooding. The soils in the Mandeville-Norris-Bolivar association should not be row-cropped because rock is near the surface.

Specialty crops cannot be localized to one association of the survey area. The spectrum covers the sandy, well drained soils of the Mandeville-Norris-Bolivar association, ideal for the production of truck crops such as sweet corn and watermelons, to the wet soils of the Zook-Dockery-Blackoar association, which are suitable for the production of vegetables. The selection of a site for the production of specialty crops is dependent upon the requirements of the particular crops, and site location should be considered individually, not collectively.

Most soils are not suited to the production of commercially valuable forest products. The main commercial value of the woodlands in the survey area is for firewood. The soils of the Mandeville-Norris-Bolivar association are well suited to the production of this commodity. Other soil associations are too wet for commercial wood production.

The soils of the Mandeville-Norris-Bolivar association are well suited to parks and extensive recreation areas. Forests enhance the beauty of most areas of these soils. All of the soils can provide suitable wildlife habitat and recreational opportunities.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Sampsel silty clay loam, 2 to 5 percent slopes, is one of several phases in the Sampsel series.

Some map units are made up of two or more major soils, such as soil complexes. A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Snead-Rock outcrop complex, 5 to 14 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 5 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

BaB—Barco loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops, ridge points, and upper parts of side slopes. Areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark brown loam about 12 inches thick. The subsoil is about 20 inches thick. The upper part is dark yellowish brown, very friable clay loam; the lower part is dark yellowish brown and strong brown, friable clay loam. The substratum to a depth of 45 inches or more is mixed, pale yellow, olive yellow, red, and strong brown soft sandstone. Scattered sandstone rocks are on the surface in some areas.

Included with this soil in mapping are small areas of deep, moderately well drained Deepwater soils and moderately deep, well drained Bolivar soils. Deepwater soils are in broad, nearly level areas where the loess mantle becomes thicker. Bolivar soils are on the more sloping ridge points where forest has encroached on the prairie. These included soils make up 5 to 15 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff from cultivated areas is medium in this Barco soil. Reaction is strongly acid or very strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility is medium, and the organic matter content is high. The

surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. In most places, root development is restricted below a depth of 20 to 40 inches by soft sandstone.

Most areas of this soil are in fescue pasture. The potential is good for small grain and other cool-season annuals. It is fair to poor for sanitary facilities and building site development.

This soil is suited to small grain, hay, and pasture. Corn, sorghums, and soybeans can be grown, but yields are reduced in most years by drought. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to building site development if footings and foundations are designed to prevent structural damage caused by the shrinking and swelling of the soil. The underlying sandstone is relatively soft and rippable in most places. Because of the moderate depth to bedrock, all sanitary facilities should be designed to overcome this limitation, or they should be connected to commercial treatment facilities. The soil does not have sufficient strength and stability to support vehicular traffic, but this limitation can be corrected by replacing the surface layer with suitable base material.

This soil is in capability subclass IIe. It is not assigned to a woodland group.

BaC—Barco loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on ridge points and short, uneven side slopes. Areas are irregular in shape and range from 10 to 65 acres.

Typically, the surface layer is dark brown loam about 6 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown, very friable loam; the middle part is brown, very friable clay loam; and the lower part is strong brown, very friable clay loam. The substratum to a depth of 66 inches or more is yellowish brown clay loam over pale yellow, soft rippable sandstone. In some eroded areas, the surface layer is less than 5 inches thick. In places, sandstone rocks are scattered on the surface. In some areas, the subsoil is thicker.

Included with this soil in mapping are small areas of moderately deep, well drained Bolivar soils; deep, moderately well drained Deepwater soils; and poorly drained Sampsel soils. Bolivar soils are in lower positions on the slope than this Barco soil, where timber vegetation advanced into areas of predominantly prairie. Deepwater soils typically are adjacent to Barco soils, where the underlying material is shale and the loess mantle is thicker. Sampsel soils are in shallow depressions and along drainageways. These included soils make up 5 to 15 percent of the unit.

Permeability is moderate, available water capacity is low or moderate, and surface runoff from cultivated areas is medium in this Barco soil. Reaction is strongly acid or very strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility is medium, but organic matter content is moderately low as a result of the loss of the surface layer by erosion. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. It tends to erode, however, if left bare during rainy periods. Root development is restricted below a depth of 20 to 40 inches by sandstone bedrock.

Most areas of this soil are in fescue pasture. The potential is good for small grain and other cool-season annuals. It is fair to poor for sanitary facilities and building site development.

This soil is suited to small grain, hay, and pasture. Corn, sorghums, and soybeans can be grown in some of the less sloping areas, but yields are reduced in most years by drought. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help prevent excessive soil loss. In a few areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to building site development that fits the slope. Foundations and footings should be constructed to prevent structural damage caused by the shrinking and swelling of the soil. The underlying sandstone beds are relatively soft and rippable in most places. Because of the moderate depth to bedrock, all sanitary facilities should be designed to overcome this limitation, or they should be connected to commercial treatment facilities. The soil does not have sufficient strength and stability to support vehicular traffic, but this limitation can be corrected by replacing the surface layer with suitable base material.

This soil is in capability subclass IVe. It is not assigned to a woodland group.

Bk—Blackoar silt loam. This nearly level, poorly drained soil is on bottom lands between streams, or former streams, and the uplands. Areas are irregular in shape and range from 5 to 200 acres. Most areas are occasionally flooded.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 8 inches thick. The subsurface layer is very dark gray, very friable silt loam about 14 inches thick. The subsoil is dark gray, very friable silt loam about 21 inches thick. The substratum to a depth of 65 inches or more is dark gray silt loam. In places, the soil is silty clay loam throughout or some horizons are silty clay loam.

Included with this soil in mapping are small areas of moderately well drained Nodaway soils and finer textured Zook soils. Nodaway soils are on natural levees along streams and former channels of streams. Zook soils are in depressions where slack water deposited fine textured material. These included soils make up 5 to 15 percent of the area.

Permeability is moderate, available water capacity is high, and runoff is slow in this Blackoar soil. The surface layer and subsoil are medium acid to neutral. Natural fertility and organic matter content are high. The surface layer is friable and easily tilled. A seasonal high water table is within a depth of 1 foot.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and some trees, if the soil is protected from flooding. Potential is fair for wildlife habitat. It is poor for most sanitary facilities and building site development.

This soil is suited to corn, soybeans, sorghums, small grain, and legumes for hay and pasture. If the soil is cultivated, early maturing crops should be used to avoid flooding in spring and fall. Minimum tillage, winter cover crops, and residue should be used to maintain tilth and increase water infiltration.

Grasses and legumes for hay and pasture grow well. Selected varieties need to be able to tolerate floods and the high water table. Grazing and haying when the soil is wet cause surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees that tolerate wet conditions, and some areas remain in native hardwoods. Pin oak, eastern cottonwood, and pecan trees grow well. Seedling mortality and the use of equipment are limitations to producing trees. Management operations need to be done during dry periods.

This soil is suited to openland or wetland wildlife. It is suited to plantings of wetland cover. Shallow-water impoundments can be constructed to improve wetland habitat. Openland wildlife can be encouraged by maintaining fields in which grain and seed crops are available for food and border cover for protection.

This soil generally is not suited to buildings and sanitary facilities because of flooding in most areas, the seasonal high water table, and low strength. Roads constructed on this soil need to be protected from flooding and constructed to prevent the soil from giving way under loads.

This soil is in capability subclass IIw and woodland ordination group 3w.

BoC2—Bolivar loam, 5 to 9 percent slopes, eroded. This moderately sloping, well drained soil is on convex ridgetops and uneven side slopes. Areas are irregular in shape and range from 6 to 100 acres.

Typically, the surface layer is dark brown loam about 8 inches thick. The subsurface layer is brown loam about 3 inches thick. The subsoil is about 18 inches thick. The upper part is dark brown, very friable clay loam; and the lower part is yellowish red, friable clay loam. The substratum to a depth of 36 inches is dark yellowish brown, soft weathered sandstone interbedded with clay loam. In places, the subsoil is thicker. In some areas, the surface layer has been mixed with the upper part of the subsoil by plowing and is dark yellowish brown or strong brown clay loam.

Included with this soil in mapping are small areas of soils that are less than 20 inches deep over sandstone. Also included are well drained Barco soils and moderately well drained Mandeville soils. Barco soils are in higher positions on the slope than this Bolivar soil, where prairie vegetation advanced into predominantly timbered areas. Mandeville soils occupy the same position on the landscape as Bolivar soils, but these soils formed in shale bedrock. These included soils make up 2 to 10 percent of the unit.

Permeability is moderate, available water capacity is low or moderate, and surface runoff is medium in this Bolivar soil. Reaction ranges from medium acid to very strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are low. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. It tends to erode when plowed, and gullies and rills form in cultivated areas. Root development is restricted below a depth of about 36 inches by soft sandstone bedrock.

Most areas of this soil are used for pasture, and a small acreage is used for hay production (fig. 9). The potential is poor for cultivated crops, but it is good for hay, pasture, and trees. It is good for most wildlife and recreational uses and poor to fair for sanitary facilities and building site development.

This soil is generally not suited to corn, soybeans, and sorghums, but it is suited to small grain and to grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of further erosion damage. Minimum tillage, winter cover crops, grassed waterways, and terraces help to prevent excessive soil loss. In a few areas, included soils are too shallow over sandstone for ter-

Figure 9.—Improved pasture on Bolivar loam.

races. Yields are reduced by insufficient soil moisture in most summers. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is wet, however, causes surface compaction, excessive runoff, and erosion. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees, and a few areas remain in native hardwoods. Seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation; by controlled burning; or by

spraying, cutting, or girdling. There are no hazards or limitations to planting or harvesting trees.

This soil is suitable for building site development if the design allows for the moderate depth to sandstone bedrock. This bedrock can be ripped in most places. The soil is generally not suited to onsite waste disposal systems because of the moderate depth to sandstone bedrock. Sanitary facilities should be designed to overcome this limitation, or they should be connected to commercial sewers or treatment facilities. The soil can support vehicular traffic, but because of its moderate shrink-swell potential, the upper layers should be replaced with a suitable base material.

This soil is in capability subclass IVe and woodland ordination group 4o.

BoD2—Bolivar fine sandy loam, 9 to 14 percent slopes, eroded. This strongly sloping, well drained soil is on convex, short, uneven side slopes. Areas are irregular in shape and range from 10 acres to more than 80 acres.

Typically, the surface layer is dark brown and yellowish brown, very friable fine sandy loam about 5 inches thick. The subsurface layer is light yellowish brown, very friable fine sandy loam about 3 inches thick. The subsoil is about 16 inches thick. The upper part is light yellowish brown, very friable fine sandy loam; and the lower part is brownish yellow, very friable loam. The substratum to a depth of about 35 or more inches is pale olive, soft weathered sandstone. In some areas, the subsoil is not so thick and sandstone is nearer the surface. In some small areas that are not eroded the surface layer is thicker.

Included with this soil in mapping are areas with steeper slopes and breaks that have rock outcrops and rocks and boulders on the surface. Also included are small areas of moderately well drained Mandeville soils and well drained Norris soils. Mandeville soils are in areas where the slope is not so steep as this Bolivar soil, and shale is the parent material. Norris soils are adjacent to Bolivar soils, and they formed in shale bedrock. These soils make up about 15 percent of the unit.

Permeability is moderate, available water capacity is low, and surface runoff is rapid in this Bolivar soil. Reaction ranges from medium acid to very strongly acid in the subsoil and varies widely in the surface layer. Natural fertility and organic matter content are low. Root development is restricted below a depth of about 36 inches by soft sandstone bedrock.

Most areas of this soil are forested. The potential is fair for trees and for grass for pasture and hay. It is fair to poor for sanitary facilities and building site development.

This soil is generally not suitable for corn, soybeans, sorghums, and small grain. If the soil is cultivated, there is a hazard of further erosion. Yields are reduced if there is a summer drought.

This soil is suited to pasture and hay. Major limitations are the low available water supply and rocks and boulders on the surface in some areas. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves moisture supplying capacity by reducing runoff. Proper stocking, uniform grazing, and a planned grazing system help to keep the grass and soil in good condition.

This soil is suited to trees, and most areas remain in native hardwoods. Seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation; by prescribed burning; or by spraying, cutting, or girdling. There are no hazards or limitations to planting or harvesting except in those areas where rocks and boulders are on the surface.

This soil is suited to building site development if foundations and footings are designed to fit the slope and the moderate depth to sandstone. This soil is generally not suitable for onsite waste disposal systems because of the slope and the moderate depth to sandstone bedrock. Sanitary facilities should be designed to overcome these limitations, or they should be connected to commercial treatment facilities. The soil can support vehicular traffic, but because of its moderate shrink-swell potential, the upper layers should be replaced with a suitable base material.

This soil is in capability subclass VIe and woodland ordination group 4o.

Br—Bremer silty clay loam. This nearly level to gently sloping, poorly drained soil is on second bottoms and terraces. It is subject to rare flooding. Areas are irregular in shape and range from 3 to 20 acres.

Typically, the surface layer is very dark gray, friable silty clay loam about 10 inches thick. The subsoil is about 53 inches thick. The upper part is very dark gray, firm silty clay loam; the middle part is very dark gray, firm, mottled silty clay; and the lower part is dark gray, firm, mottled silty clay loam. Escarpments and toe slopes are in some areas of this unit.

Included with this soil in mapping are small areas of somewhat poorly drained Freeburg and Lightning soils. These soils are on or near the escarpments where timber influences soil formation. These included soils make up 5 to 10 percent of the unit.

Permeability is slow, available water capacity is high, and runoff is slow in this Bremer soil. Reaction is slightly acid in the subsoil. Organic matter content and natural fertility are high. The surface layer is friable and easily tilled, but the soil tends to remain wet. If tilled while wet, the surface layer crusts or puddles. Erosion is a hazard on terrace escarpments and toe slopes if erosion control practices are not used.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is poor for sanitary facilities and building site development.

This soil is suited to corn, soybeans, sorghums, small grain, and grasses and legumes for hay and pasture (fig. 10). If the soil is cultivated, drainage is needed in the broad, nearly level areas and erosion control is needed on escarpments and toe slopes. Open ditches, waterways, minimum tillage, and cover crops are needed. Returning crop residue to the soil or the regular addition of organic material helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to pasture or hay if water-tolerant grasses and legumes are grown. Timely deferment of grazing and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil generally is not suitable for building site development and sanitary facilities. Wetness, the shrink-swell potential, low strength, and possibility of flooding are limitations.

This soil is in capability subclass IIw and woodland ordination group 3w.

Figure 10.—Fescue hay on Bremer silty clay loam.

DpB—Deepwater silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex ridgetops and side slopes. Areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is dark brown, very friable silt loam about 10 inches thick. The subsoil is about 65 inches thick. The upper part is very dark grayish brown, friable silty clay loam; the middle part is dark brown and brown, friable silty clay loam; and the lower part is yellowish brown, firm silty clay loam. In places, the subsoil is not so thick. In some areas the surface layer is loam, and in some areas the subsoil is clay loam and sandstone is the dominant bedrock. These areas are near Barco soils.

Included with this soil in mapping are small areas of well drained Barco soils and moderately well drained Mandeville soils. Also included are areas of poorly drained Haig soils and somewhat poorly drained Sampsel soils. Barco soils are in areas where the loess mantle is thinner and sandstone is the dominant parent material. Mandeville soils are on the more sloping ridge points where timber vegetation has influenced soil formation. Haig and Sampsel soils are in shallow depressions and nearly level areas. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff from cultivated areas is medium in this Deepwater soil. Reaction is neutral to strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are high. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to good for sanitary facilities and building site development.

This soil is suited to corn, soybeans, sorghum, small grain, and grasses and legumes for hay and pasture. Minimum tillage, contour farming, winter cover crops, and grassed waterways help to prevent excessive erosion. In a few areas, slopes are long enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility and increase water infiltration.

The use of the soil as pastureland and hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. Seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation; by controlled burning; or by spraying, cutting, or girdling. There are no hazards or limitations to planting or harvesting trees.

This soil is suited to building site development and to onsite waste disposal if proper design and installation procedures are used. It supports vehicular traffic if the base material is strengthened or replaced. The moderate permeability is a limitation to septic tank filter fields, but this limitation can be overcome by increasing the size of the field.

This soil is in capability subclass IIe and woodland ordination group 2o.

DpC2—Deepwater silt loam, 5 to 9 percent slopes, eroded. This moderately sloping, moderately well drained soil is on convex side slopes and ridge points. Areas are irregular in shape and range from 2 to 45 acres.

Typically, the surface layer is dark brown, very friable silt loam about 8 inches thick. The subsoil is about 40 inches thick. The upper part is dark brown, friable silty clay loam, and the lower part is yellowish brown, firm silty clay loam. The substratum is brown, mottled silty clay loam to a depth of 54 inches or more. In places, the subsoil is not so thick. In some areas, the surface layer is loam, and in some areas, the subsoil is clay loam and sandstone is the dominant bedrock. In some areas where the surface layer has been mixed with the original surface layer by plowing, the surface layer is dark brown silty clay loam.

Included with this soil in mapping are small areas of well drained Barco and Polo soils. Also included are small areas of somewhat poorly drained Sampsel and Gorin soils. Barco and Polo soils are on higher positions on slopes and in areas of ridge breaks. Sampsel and Gorin soils are near the heads of drainageways and in shallow depressions. These included soils make up 5 to 15 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff is medium in this Deepwater soil. Reaction is neutral to strongly acid in the subsoil. It varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are high. The surface layer is very friable and easily tilled throughout a wide range in moisture content. In areas where the surface layer is mixed with the subsoil, it tends to crust or puddle after hard rains.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to good for most engineering uses.

This soil is suited to corn, soybeans, sorghums, small grain, and grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive erosion. In some areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes for pasture and hay are well suited to this soil, and they are effective in controlling erosion. Adequate fertility needs to be maintained for maximum growth. Pasture should not be grazed when too wet to avoid packing and crusting, and it should be clipped if grazed unevenly. Hay should be harvested at the proper time and height to allow maximum growth.

This soil is suited to trees. Seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation; by controlled burning; or by spraying, cutting, or girdling. There are no hazards or limitations to planting or harvesting trees. Stocking rates should be maintained at a level that protects the soil from erosion.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. It does not have sufficient strength and stability for local roads and streets, but this limitation can be corrected by strengthening or replacing the base material. The moderate permeability is a limitation to septic tank absorption fields, but this limitation can be overcome by increasing the size of the field.

This soil is in capability subclass IIIe and woodland ordination group 2o.

Dt—Dockery silty clay loam. This nearly level, somewhat poorly drained soil is on bottom land where streams and former meanders have formed natural levees. Areas range from 20 acres to more than 100 acres, and they range from long and narrow to wide. Most areas are frequently flooded.

Typically, the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The underlying layers are dark grayish brown silty clay loam; grayish brown silt loam; and grayish brown, mottled silt loam to a depth of 60 inches or more. In places, dark, fine textured layers are at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of moderately well drained Nodaway soils and poorly drained Zook soils. Nodaway soils are along natural levees. Zook soils are in low depressions where slack water has deposited fine textured material. These included soils make up 4 to 7 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff is slow in this Dockery soil. Reaction is slightly acid or neutral. Natural fertility and organic matter content are high. The surface layer is friable and easily tilled, but flooding, slow runoff, and a high water table at a depth of 1 foot to 3 feet limit tillage.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture and some trees if the soil is protected from flooding. It is poor for sanitary facilities and building site development.

This soil is suited to corn, soybeans, sorghums, and small grain if it is protected from flooding. Minimum tillage, winter cover crops, and crop residue are needed to maintain tilth and increase water infiltration.

Grasses and legumes for hay and pasture grow well. Selected varieties need to be able to tolerate floods and the high water table. Grazing and haying when the soil is wet causes surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods keep the pasture and soil in good condition.

This soil is suited to trees that tolerate wet conditions, and some areas remain in native hardwoods. Pin oak, eastern cottonwood, and pecan trees grow well. Use of equipment and plant competition are limitations to producing trees. Management practices need to be done during dry periods.

This soil is suited to openland or wetland wildlife. Wetland plants grow on this soil, but growth and food production are average. Shallow-water impoundments can be constructed to improve wetland habitat. Openland wildlife can be encouraged by maintaining a maximum interspersion of fields in which grain and seed crops are available for feed and border cover for protection.

This soil is generally not suited to sanitary facilities and building site development because of frequent flooding in most areas and low strength under loads. Buildings and roads need to be protected from flooding and constructed to prevent the soil from giving way under loads. The soil is a good source of topsoil.

This soil is in capability subclass IIw and woodland ordination group 3w.

Fs—Freeburg silt loam. This nearly level to gently sloping, somewhat poorly drained soil is on terraces and second bottoms. It is subject to rare flooding. Areas are irregular in shape and range from 3 to 20 acres.

Typically, the surface layer is dark brown, very friable silt loam about 7 inches thick. The subsurface layer is brown, very friable silt loam about 6 inches thick. The subsoil is about 46 inches thick. The upper part is brown, very friable silt loam; the middle part is dark grayish brown and brown, friable, mottled silty clay loam; and the lower part is dark brown, friable, mottled silty clay loam. The substratum to a depth of 60 inches or more is dark brown, friable, mottled silty clay loam. In places, the surface layer is darker and the subsurface layer is gray. In some areas, the surface layer has been mixed with the upper part of the subsoil by plowing. These areas are on escarpments at the edge of the unit. On a few individual terraces, air and water movement is better and the soil is darker.

Included with this soil in mapping are small areas of poorly drained Bremer soils and somewhat poorly drained Lightning soils. These soils are in nearly level areas or depressions near the center of the unit. The included soils make up about 5 percent of the unit.

Permeability is moderately slow, available water capacity is high, and surface runoff is slow in this Freeburg soil. Reaction is medium acid to very strongly acid in the subsoil. Natural fertility and organic matter content are

low, but the soil responds well to fertilization. The surface layer is very friable and easily tilled, but it remains wet for long periods because it is nearly level.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is poor for sanitary facilities and building site development.

This soil is suited to sorghums, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of wetness during planting and harvesting. Minimum tillage, winter cover crops, and contouring on the escarpments help to control erosion. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

This soil produces high quality grasses and legumes for hay and pasture if water-tolerant species are grown. Restricted use during wet periods helps to keep the pasture and soil in good condition and reduces surface compaction.

This soil is suited to openland wildlife. Diversity, interspersion, and the edge effect should be established by planting hedgerows and field borders and controlling brush. The soil is suited to wetland wildlife. Drainage should be avoided, and shallow impoundments and plantings should be established.

This soil is generally not suitable for building site development and onsite waste disposal. It is a poor site for streets and roads. Sewage lagoons can be built if the site is above flood level.

This soil is in capability subclass IIw and woodland ordination group 3o.

GoC2—Gorin silt loam, 5 to 9 percent slopes, eroded. This moderately sloping, somewhat poorly drained soil is on convex side slopes. Areas are irregular in shape and range from 4 to 50 acres.

Typically, the surface layer is dark brown, very friable silt loam about 5 inches thick. The subsoil is about 55 inches thick. The upper part is brown, firm silty clay; the middle part is light grayish brown and yellowish brown, firm, mottled silty clay loam; and the lower part is brown, firm silty clay loam. In places, the subsoil is not so thick. In a few areas that are not eroded, the silt loam surface layer is 12 to 15 inches thick. In some areas, all of the surface layer has been removed by rills and gullies and is silty clay loam or silty clay.

Included with this soil in mapping are small areas of moderately well drained Deepwater soils and somewhat poorly drained Sampsel soils. Deepwater soils are on narrow ridge points and the upper parts of side slopes above Gorin soils. Sampsel soils are along the upper slopes and heads of drainageways. The included soils make up 5 to 15 percent of the unit.

Permeability is slow, available water capacity is high, and surface runoff from cultivated areas is medium in this Gorin soil. Reaction ranges from neutral to strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility is medium, and organic matter content is low because of erosion. The surface layer varies in texture over most of the area. It is friable and easily tilled in uneroded areas, firm and hard to till in eroded areas, and almost untillable in severely eroded spots. It tends to crust or puddle after hard rains, especially in eroded areas where the surface layer contains subsoil material. Root development is restricted in some areas because of the compact, fine textured subsoil.

Most areas of this soil are in grass for pasture and hay. The potential is good for grasses and legumes for pasture and hay. It is poor for sanitary facilities and building site development.

Cultivated crops can be grown on this soil, but yields are reduced by erosion and by drought in July and August in most years. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to grasses and legumes for hay and pasture. The main concerns of management are related to the low natural fertility. An adequate plant cover and ground mulch help to prevent excessive soil loss and improve the moisture supplying capacity by reducing runoff. Proper stocking, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the pasture and soil in good condition.

This soil is suited to trees. The seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. There are no hazards or limitations to planting or harvesting trees.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the shrinking and swelling of the soil. Sanitary facilities should be designed to overcome the limitations, or they should be connected to commercial sewers and treatment facilities. Local roads and streets need to be graded to shed water, and suitable base material needs to be hauled in from another location.

This soil is in capability subclass IVe and woodland ordination group 4c.

Hg—Haig silt loam. This nearly level, poorly drained soil is on broad, convex ridgetops. Areas are long and wide and range from 80 to 300 acres.

Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is black, friable silty clay loam about 3 inches thick. The subsoil is about 54 inches thick. The upper part is black, firm silty clay loam; the middle part is black, very firm, mottled silty clay; and the lower part is grayish brown, mottled silty clay and gray, mottled silty clay loam (fig. 11). In some areas the

surface layer is browner. On some of the narrower ridges, the slope is about 3 percent.

Figure 11.—Profile of Haig silt loam showing coarse blocky structure.

Included with this soil in mapping are small areas of somewhat poorly drained Macksburg and Sampsel soils. Macksburg soils are on the more nearly rounded ridgetops or mounds, and Sampsel soils are near the heads of drainageways. These included soils make up 2 to 10 percent of the unit.

Permeability is slow or very slow, available water capacity is high, and runoff is very slow in this Haig soil. Reaction is slightly acid or medium acid in the subsoil. Natural fertility and organic matter content are high. The surface layer is friable and easily tilled, but the soil is slow to dry, which limits tillage in some years.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is poor for some sanitary facilities and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Terraces, minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

Grasses and legumes for hay and pasture grow well. Selected varieties need to be able to grow well under wet conditions. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soils from becoming saturated.

Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. Properly designed sewage lagoons can be used for onsite waste disposal.

This soil is in capability subclass IIw. It is not assigned to a woodland ordination group.

Hp—Haplaquents-Urban land complex. This complex consists of a nearly level, fine textured, poorly drained soil that has been graded, cut, filled or otherwise disturbed during construction and urbanization. It is in one area of about 1,600 acres on Whiteman Air Force Base. It is 55 to 65 percent Haplaquents and 30 to 40 percent Urban land. Haplaquents and Urban land are so intricately mixed, or so small in size, that it is not practical to map them separately.

Typically, Haplaquents are 55 percent cuts and 45 percent fills. Cuts range from a few inches to 12 feet and average about 5 feet. These cuts cause silty clay loam and silty clay material to be exposed at the surface. Fills

range from a few inches to 10 feet and average about 4 feet. The fills also have silty clay loam and silty clay material exposed at the surface.

Urban land is covered by streets, airplane runways, taxiways, parking aprons, airplane hangars, and buildings that obscure or alter the soil so that identification is not feasible.

Included in mapping are small areas of poorly drained Haig soils and somewhat poorly drained Sampsel soils. These soils are in relatively undisturbed areas where soil identification is still possible. These included soils make up about 5 percent of the complex.

Haplaquents have slow or very slow permeability. Surface runoff is medium to slow, and available water capacity is low to medium. Natural fertility and organic matter content are very low to medium.

Haplaquents are planted to grass for erosion control and hay. Because of location, these soils are not suited to cultivation. The potential is poor for sanitary facilities and building site development.

Grasses and legumes for hay will grow on Haplaquents. Selected varieties need to tolerate wet conditions. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves moisture supplying capacity by reducing runoff.

This complex is suited to building site development if foundations and footings are designed to prevent the structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around the buildings to keep the soil from becoming saturated. Commercial treatment plants should be used to dispose of sewage. Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location.

This complex is not assigned to a capability group or a woodland ordination group.

HtA—Hartwell silt loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on broad ridgetops. Areas are long and broad, follow the ridgetop, and range from 50 acres to more than 800 acres.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 8 inches thick. The subsurface layer is grayish brown and light brownish gray, very friable silt loam about 4 inches thick. The subsoil is about 42 inches thick. The upper part is very dark grayish brown, very firm silty clay; the middle part is dark grayish brown, very firm silty clay; and the lower part is light brownish gray, firm, mottled silty clay loam. The substratum to a depth of 60 inches or more is grayish brown, firm, mottled silty clay loam. In places, the surface layer is thicker.

Included with this soil in mapping are small areas of somewhat poorly drained Haig soil. This darker soil is on ridgetops and makes up about 5 percent of the unit.

Permeability is slow, available water capacity is moderate, and surface runoff is slow in this Hartwell soil. Organic matter content and natural fertility are medium. Reaction is neutral to strongly acid. Root development may be restricted because of the abrupt change in texture from the surface layer to the subsoil.

Most areas of this soil are in grass for pasture and hay. The potential is fair for corn, soybeans, grain sorghum, and small grain. It is poor for sanitary facilities and building site development.

If this soil is cultivated, yields are reduced in many years by summer drought. Management that includes moisture conservation is needed. Minimum tillage, winter cover crops, ground mulch, and returning crop residue to the soil or the regular addition of other organic material help to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to pasture and hay. Major limitations are the hazard of seasonal wetness, the moderate available water capacity, and the low rainfall in summer. Management that maintains an adequate plant cover and ground mulch improves the moisture supplying capacity. Removal of livestock during wet periods helps to protect the soil from compaction. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil is suited to building site development if foundations and footings are designed to prevent the structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soil from becoming saturated. Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. Sewage lagoons should be used for onsite sewage disposal.

This soil is in capability subclasss IIw. It is not assigned to a woodland ordination group.

HtB2—Hartwell silt loam, 2 to 5 percent slopes, eroded. This gently sloping, somewhat poorly drained soil is on ridgetops and at the heads of drainageways. Areas are irregular in shape and range from 50 to 500 acres.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 7 inches thick. The subsoil is 32 inches thick. The upper part is very dark grayish brown, firm silty clay; the middle layer is dark grayish brown, very firm silty clay loam; and the lower part is gray, very firm, mottled silty clay loam. The substratum to a depth of about 62 inches is yellowish brown, firm silty clay loam. In some areas, this soil is severely eroded and the surface layer is silty clay loam. In some areas, the surface layer is thicker.

Included with this soil in mapping are small areas of somewhat poorly drained Sampsel soils, moderately well drained Deepwater soils, and well drained Barco soils. Sampsel soils are on the steeper side slopes. Deepwater

soils are in areas where shale bedrock is near the surface. Barco soils are in areas where sandstone is the dominant underlying material. These included soils make up about 3 percent of the unit.

Permeability is slow, available water capacity is moderate, and surface runoff is slow in this Hartwell soil. Organic matter content and natural fertility are medium. Reaction is neutral to strongly acid. Root development can be restricted because of the abrupt change in texture from the surface layer to the subsoil.

Most areas of this soil are in grass for pasture and hay. The potential is fair for corn, soybeans, grain sorghum, and small grain. It is poor for sanitary facilities and building site development.

If this soil is cultivated, yields are reduced in many years by summer drought. Management that includes moisture conservation is needed. Minimum tillage, winter cover crops, ground mulch, and returning crop residue to the soil or the regular addition of other organic material help to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to building site development if foundations and footings are designed to prevent the structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soil from becoming saturated. Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. Sewage lagoons should be used for onsite sewage disposal.

This soil is in capability subclass IIe. It is not assigned to a woodland ordination group.

HxC—Higginsville silt loam, 4 to 7 percent slopes. This moderately sloping, somewhat poorly drained soil is on the upper part of convex to slightly concave side slopes. Areas are irregular in shape and range from 2 to 70 acres.

Typically, the surface layer is black, very friable silt loam about 8 inches thick. The subsoil is about 61 inches thick. The upper part is black, friable silty clay loam; the middle part is very dark gray, firm silty clay loam; and the lower part is dark grayish brown and gray, firm, mottled silty clay loam. In some eroded areas, the subsoil is exposed on the surface. It is also exposed on the sides of some of the deeper rills. Also included are small areas that are eroded. In a few small areas, lime concretions are in the substratum.

Included with this soil in mapping are small areas of poorly drained Haig soils and somewhat poorly drained Macksburg and Sampsel soils. The nearly level Haig and gently sloping Macksburg soils are on broad ridgetops. Sampsel soils are on the lower part of drainageways. These included soils make up 5 to 10 percent of the unit.

Permeability is slow, available water capacity is high, and surface runoff is medium in this Higginsville soil. Reaction ranges from slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content mainly are high, but they are low in small areas where erosion has removed all of the surface layer. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle after hard rains, however, in areas where it contains subsoil material.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is fair for sanitary facilities and building site development.

This soil is suited to corn, soybeans, sorghums, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Most areas can be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland and hayland effectively controls erosion and improves soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods keep the pasture and soil in good condition.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soils from becoming saturated.

Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. Sewage lagoons should be used for onsite waste disposal.

This soil is in capability subclass IIIe. It is not assigned to a woodland ordination group.

Ka—Kanima shaly silty clay loam, 30 to 60 percent slopes. This soil is very steep and well drained. It is in spoil areas that remain after strip mining operations. It is a mixture of shale, sandstone, limestone, and the original mantle of soil that has been radically altered. Excavated pits that contain varying amounts of water are in most areas. Areas range from 2 to 640 acres.

Typically, the surface layer is light gray, friable shaly silty clay loam about 7 inches thick. The substratum is light brownish gray and gray, friable shaly silty clay loam to a depth of 60 inches or more. It commonly is as much as 85 percent coarse fragments, and pockets of the original soil material are scattered throughout. In some areas, sandstone and limestone fragments are scattered on the surface. A few areas are relatively undisturbed and are similar to the original soil. Black, extremely acid

deposits are in areas that were used to wash the mined coal.

Included with this soil in mapping are small areas of somewhat poorly drained Hartwell soils. These soils are on the nearly level ridgetops and at the heads of drainageways. Also included are areas of moderately well drained Deepwater soils that are on the less sloping, more uniform side slopes. These included soils make up about 5 percent of this unit.

Permeabilty is moderately rapid in areas where the percentage of coarse fragments is high and moderate where the percentage is lower. Reaction ranges from moderately alkaline to extremely acid throughout the profile. Natural fertility and organic matter content are low.

Most areas of this soil are in poor quality timber and shrubs. The potential is fair for pasture if some leveling and shaping is done. It is poor for farming, sanitary facilities, and building site development.

This soil is best suited to grasses and legumes for pasture if leveling and shaping is done before seeding. Management that maintains an adequate plant cover for ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing reduce the protective plant cover and cause deterioration of the plant community. Planned grazing that maintains proper stocking, uniform grazing distribution, and timely deferment of grazing helps to keep the pasture and soil in good condition. Some of the water filled pits have good potential as irrigation water supplies or livestock watering systems.

Some leveled areas can be cultivated, but yields are reduced by the poor fertility and low available water capacity. Excessive erosion occurs on the steeper, shallower areas that are adjacent to the nearly level areas.

This soil is suited to most types of wildlife. The water filled pits can be developed to provide habitat for wetland wildlife. Commonly, water is adequate and food supply is sufficient for many species of desirable fish. The spoil areas around the excavated pits support species of vegetation suited to openland wildlife.

This soil is in capability subclass VIIs. It is not assigned to a woodland ordination group.

Lg—Lightning silt loam. This nearly level, somewhat poorly drained soil is on low terraces and bottom lands. Areas are rectangular to irregular in shape and range from 2 to 135 acres. Most areas are occasionally flooded.

Typically, the surface layer is grayish brown, very friable silt loam about 8 inches thick. The subsurface layer is light brownish gray, very friable silt loam about 6 inches thick. The subsoil is about 45 inches thick. It is light brownish gray, grayish brown, and dark grayish brown, friable to firm, mottled silty clay loam. The substratum is gray, mottled silty clay loam to a depth of 60 inches or more. In places, the surface layer is darker. In areas where the terrace escarpment joins adjacent alluvial areas, slopes are 3 to 7 percent. Some escarpments are eroded.

Included with this soil in mapping are small tracts of moderately well drained Nodaway soils that are below the terrace escarpment and small tracts of somewhat poorly drained Freeburg soils that are near the terrace escarpment. These included soils make up 5 to 10 percent of the unit.

Permeability is very slow, available water capacity is moderate to high, and surface runoff is very slow in the Lightning soil. Reaction is mostly very strongly acid throughout the soil but ranges from neutral or slightly acid to very strongly acid. Organic matter content and natural fertility are low. The surface layer is very friable and easily tilled, but runoff is so slow that tillage is delayed by wetness in most years.

Most areas of this soil are used for soybeans or grain sorghum. Some areas are in fescue for hay and pasture. The potential is fair for cultivated crops, hay, pasture, and trees. It is poor for sanitary facilities and building site development.

This soil is suited to soybeans, sorghums, small grain, and grasses for hay and pasture. Corn can be grown, but yields are reduced by wetness in spring and dryness in summer. Minimum tillage, winter cover crops, and returning crop residue to the soil help to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to hay and pasture if water-tolerant grasses and legumes are grown. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

Trees are suited to this soil. Water-tolerant species should be selected. Cuttings and seedlings survive and grow well if competing vegetation is controlled or removed. A moderate hazard exists when seeding for trees because the soil is saturated during wet periods. Management practices should take place during dry periods.

This soil is suited to wetland or openland wildlife and is well suited to woodland wildlife. It is suited to hardwood and coniferous trees, grasses, and legumes, which provide cover and food essential in maintaining a large population of wildlife.

This soil generally is not suited to building site development and onsite waste disposal. Areas used for these purposes need to be artificially drained and protected from flooding. Dwellings and small buildings need to be protected from flooding and constructed without basements. Also, foundations and footings need to be designed to prevent structural damage caused by the shrinking and swelling of the soil. Septic tank filter fields commonly are not suitable, and sewage lagoons need levees that are built at an elevation higher than possible floods.

Low strength, shrink-swell potential, wetness, and flooding are problems to highways and roads. Subgrade material should be taken from other soils.

This soil is in capability subclass IIIw and woodland ordination group 3w.

MaB—Macksburg silt loam, 1 to 4 percent slopes. This gently sloping, somewhat poorly drained soil is on broad ridgetops. Areas are fairly wide and run the length of the ridge. They range from 10 to 100 acres.

Typically, the surface layer is black, very friable silt loam and silty clay loam about 10 inches thick. The subsurface layer is very dark brown, friable silty clay loam about 10 inches thick. The subsoil is about 38 inches thick. The upper part is dark grayish brown, firm silty clay loam; and the lower part is yellowish brown, friable, mottled silty clay loam. The substratum is grayish brown, mottled silty clay loam to a depth of 60 inches or more. In places, the soil is slightly browner. In some areas that are nearly level, the surface layer is thicker, the subsoil is finer textured, and the soil is poorly drained. In some eroded areas, the surface layer contains subsoil material.

Included with this soil in mapping are small areas of moderately well drained Deepwater soils on rounded ridge points and areas of moderately well drained Weller soils in areas where trees have encroached on prairie. These included soils make up 2 to 10 percent of the unit.

Permeability is moderately slow, available water capacity is high, and surface runoff is slow in this Macksburg soil. Reaction ranges from slightly acid to strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Organic matter content and natural fertility are high. The surface layer is friable and easily tilled throughout a wide range in moisture content. It tends to crust or puddle after hard rains, however.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is poor to fair for sanitary facilities and building site development.

This soil is suited to corn, soybeans, grain sorghums, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas slopes are long and steep enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion and improves soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to most types of wildlife habitat. Field borders, hedgerow plantings, and areas of mixed grain provide food near wildlife cover that encourages larger populations of wildlife.

This soil is suited to building site development and onsite waste disposal if proper design and installation procedures are used. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soil from becoming saturated. Local roads should be graded to shed water, and suitable base material needs to be hauled in from another location. Sewage logoons should be used for onsite waste disposal.

This soil is in capability subclass IIe. It is not assigned to a woodland ordination group.

MdB—Mandeville silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex, narrow ridgetops and the upper parts of side slopes. Areas are long and narrow and range from 5 to 75 acres.

Typically, the surface layer is dark grayish brown, very friable silt loam about 4 inches thick. The subsurface layer is yellowish brown, very friable silt loam about 6 inches thick. The subsoil is yellowish brown, friable silty clay loam about 30 inches thick. The substratum is light brownish gray weathered shale to a depth of 51 inches or more. In places, the subsoil is thicker. In places, the substratum is silty clay.

Included with this soil in mapping are small areas of moderately well drained Deepwater soils and well drained Norris soils. These included soils make up 5 to 15 percent of the unit.

Permeability and available water capacity are moderate and surface runoff is medium in this Mandeville soil. The surface layer is very friable and easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is low. Organic matter content is low, and natural fertility is medium. Reaction is strongly acid throughout unless the soil is limed. Where limed, the surface layer is medium acid or slightly acid. Root development is restricted below a depth of 20 to 40 inches by shale bedrock.

Most areas of this soil are in grass for hay and pasture. The potential is fair for cultivated crops and trees. It is fair to poor for sanitary facilities and building site development. Potential is good for woodland or openland wildlife but very poor for wetland wildlife.

This soil is suited to pasture and hay. Major concerns of pasture management are related to the hazard of erosion and the moderate available water capacity. The soil tends to be droughty as a result of the moderate available water capacity and low rainfall in summer. Management that maintains an adequate plant cover and

ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil is suited to soybeans, sorghum, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. If the soil is used for corn, yields are reduced in most years if there is a summer drought. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. If terraces are built, cuts should not be deep because of the moderate depth to shale. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to trees, and a few areas remain in native hardwoods. There are no hazards or limitations to planting or harvesting trees. Tree seeds, cuttings, and seedlings survive and grow well.

This soil is suited to building site development, but sites where the depth to shale bedrock does not interfere with construction of foundations and footings should be selected. All sanitary facilities should be connected to commercial sewers. Local roads and streets need to be graded to shed water and constructed on the contour if possible.

This soil is in capability subclass IIe and woodland ordination group 4o.

MdC—Mandeville silt loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on convex side slopes and narrow ridgetops. Areas are regular to irregular in shape and range from 4 to 105 acres.

Typically, the surface layer is dark grayish brown, very friable silt loam about 3 inches thick. The subsurface layer is yellowish brown and brown, very friable silt loam about 3 inches thick. The subsoil is strong brown, friable silty clay loam about 23 inches thick. The substratum is multicolored, mixed weathered shale to a depth of 60 inches or more. In places, the surface layer is thicker. In some areas, the surface layer has been mixed with the upper part of the subsoil by plowing and is yellowish brown silty clay loam. In some small areas, slopes are more than 9 percent.

Included with this soil in mapping are small areas of somewhat poorly drained Gorin soils, well drained Norris soils, and somewhat poorly drained Sampsel soils. Norris soils are on steep, narrow ridgetops or steeper side slopes below Mandeville soils. Gorin and Samsel soils are in drainageways. These included soils make up 5 to 15 percent of the unit.

Permeability and available water capacity are moderate, and surface runoff is medium in this Mandeville soil. The surface layer is very friable and is easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is low. Organic matter content is low, and natural fertility is medium. Reaction is strongly acid in the subsoil. Root development is restricted below a depth of about 40 inches by shale bedrock.

Most areas of this soil are in grass for pasture and hay. The potential is fair for cultivated crops and trees. It is poor for sanitary facilities and building site development. It is good for woodland and openland wildlife.

This soil is suited to pasture and hay. Major concerns of pasture management are related to the hazard of erosion and the moderate available water capacity. The soil tends to be droughty as a result of the moderate available water capacity and low rainfall in summer. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil is suited to soybeans, sorghums, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. If terraces are built, cuts should not be deep because of the moderate depth to shale. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to trees, and some areas remain in native hardwoods. There are no hazards or limitations to planting or harvesting trees, but logging roads and skid trails should be constructed on the contour if possible to prevent gullies from starting. Tree seeds, cuttings, and seedlings survive and grow well.

This soil is suited to building site development, but sites where the depth to shale bedrock does not interfere with construction of foundations and footings should be selected. All sanitary facilities should be connected to commercial sewers. Local roads and streets need to be graded to shed water and constructed on the contour if possible.

This soil is in capability subclass IVe and woodland ordination group 4o.

Nd—Nodaway silt loam. This nearly level, moderately well drained soil is on bottom lands along streams or former streams. Areas are mainly long and narrow, but they are wider along the major streams. They are regular in shape and range from 5 to 200 acres. Most areas are subject to common flooding.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 9 inches thick. The underlying material to a depth of 60 inches or more is dark grayish

brown and very dark grayish brown, friable silt loam. In narrow, small valleys, the soil may be darker. In some former stream channels, slopes are more than 2 percent.

Included with this soil in mapping are small areas of poorly drained Blackoar soils and somewhat poorly drained Freeburg soils. Blackoar soils are in shallow depressions, and Freeburg soils are on small terraces. These included soils make up 3 to 8 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff is medium in this Nodaway soil. Reaction is neutral or slightly acid. Natural fertility and organic matter content are high. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is poor for sanitary facilities and building site development.

This soil is well suited to corn, soybeans, sorghums, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, planting and harvesting should be done to avoid flooding. Minimum tillage, winter cover crops, and crop residue should be used to maintain tilth and increase water infiltration.

Grasses and legumes for hay and pasture grow well. Selected varieties should tolerate floods of short duration. Grazing and haying when the soil is wet causes surface compaction and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees, and areas along streams and former streams remain in native hardwoods. Black walnut, silver maple, and cottonwood trees grow well. Seeds, cuttings, and seedlings grow well if competing vegetation is controlled or removed. There are no hazards or limitations to planting or harvesting trees.

This soil generally is not suited to sanitary facilities and building site development because of common flooding in most areas. The soil is a good source of topsoil and cover for sanitary landfill. It tends to sluff and compress when used as material for dikes and levees.

This soil is in capability subclass IIw and woodland ordination group 2o.

NoD—Norris shaly silt loam, 5 to 14 percent slopes. This sloping to strongly sloping, well drained soil is on convex, narrow ridgetops and side slopes. Areas range from 3 to 150 acres in size.

Typically, the surface layer is very dark grayish brown, very friable shaly silt loam about 2 inches thick. The subsoil is about 14 inches thick. The upper part is yellowish brown, very friable shaly silt loam, and the lower part is light olive brown, firm shaly silt loam. The substratum to a depth of about 60 inches or more is yellowish brown shaly silty clay loam and olive gray, thin bedded, soft micaceous shale. In places, the subsoil is thicker and finer textured. In some eroded areas, most of the original surface layer has been removed and subsoil material is exposed at the surface. In a few areas, slopes are more than 14 percent.

Included with this soil in mapping are small areas of well drained Bolivar soils and moderately well drained Mandeville soils. These soils are on side slopes above this Norris soil. Also included are small areas of soils that have thin beds of sandstone and limestone at the surface. These included soils make up about 10 percent of the area.

Permeability is moderate, available water capacity is low, and surface runoff is medium or rapid in this Norris soil. Reaction in the subsoil is strongly acid or very strongly acid. Natural fertility is low, and organic matter content is very low. The surface layer is very friable and easily tilled, but root development is restricted below a depth of 15 inches by the shale bedrock.

Most areas of this soil are used for hardwood forest. The potential is poor for trees, cultivated crops, and grass and legumes for hay and pasture. It is fair to poor for sanitary facilities and building site development.

Trees grow slowly and generally start to rot or develop hollow places before they reach a harvestable size. If trees are grown, the slope aspect should determine the site. Logging roads and skid trails should be constructed on the contour.

This soil can be used for pasture. Major concerns of pasture management are related to the hazard of erosion and the low available water supply. The soil tends to be droughty as a result of the low available water capacity and the water loss caused by runoff. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil is poorly suited to corn, soybeans, and small grain. If the soil is cultivated, there is a hazard of severe erosion damage as a result of steep slopes. Stoniness, low available water capacity, and steep slopes are limitations.

This soil is suited to building site development if building sites are on less sloping areas and if the design prevents damage caused by slippage of the base material. The underlying shale beds are soft and unstable. Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. All sanitary facilities should be connected to commercial treatment facilities.

This soil is in capability subclass VIe and woodland ordination group 5d.

NoF—Norris shaly silt loam, 14 to 35 percent slopes. This moderately steep and steep, well drained

soil is on convex side slopes. Areas are irregular or regular in shape and range from 8 to 160 acres.

Typically, the surface layer is very dark grayish brown, very friable shaly silt loam about 3 inches thick. The subsoil is about 11 inches thick. The upper part is yellowish brown, friable silty clay loam, and the lower part is brownish yellow, firm shaly silty clay loam. The substratum to a depth of about 28 inches or more is multicolored, soft, fine, platy weathered shale. In places, the subsoil is thicker and not so fine textured, and in places, it is exposed at the surface.

Included with this soil in mapping are small areas of well drained Bolivar soils and moderately well drained Mandeville soils. These soils are on side slopes above this Norris soil. Also included are small areas of soils that have thin beds of sandstone and limestone at the surface. Shale outcrops are on steeper points, breaks, and side slopes. These included soils make up 5 to 10 percent of the unit.

Permeability is moderate, available water capacity is low, and surface runoff is rapid in this Norris soil. Reaction is strongly acid or very strongly acid in the subsoil. Natural fertility is low, and organic matter content is very low. The surface layer is very friable and easily tilled, but root development is restricted below a depth of 14 inches by the shale bedrock.

Most areas of this soil are used for hardwood forest. The potential is poor for trees, cultivated crops, and grasses and legumes. It also is poor for sanitary facilities and building site development.

Trees grow slowly and generally start to rot or develop hollow places before they reach a harvestable size. Certain areas are suited to harvestable trees, however. If trees are grown, the slope aspect should determine the site. Logging roads and skid trails should be constructed on the contour.

This soil can be used for pasture. Major concerns of pasture management are related to the hazard of erosion and the low available water supply. The soil tends to be droughty as a result of the low available water capacity and the water loss caused by runoff. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil is poorly suited to corn, soybeans, and small grain. If the soil is cultivated, there is a hazard of severe erosion damage as a result of the steep slopes. Stoniness, low available water capacity, and steep slopes are limitations.

This soil is poorly suited to wildlife habitat, but it provides plant cover and ground and tree dens for wildlife that obtain food from surrounding soils.

This soil generally is not suited to building site development and onsite waste disposal. The underlying shale beds are soft and unstable. If buildings are constructed on this soil, less sloping areas should be selected and foundations and footings should be designed to prevent damage caused by slippage of the base material. Local roads and streets need to be graded to shed water, and suitable base material needs to be hauled in from another location. All sanitary facilities should be connected to commercial treatment facilities.

This soil is in capability subclass VIIe and woodland ordination group 5d.

Pd—Pits, quarries. This unit consists of narrow, elongated, small to large mine pits and irregularly shaped, open quarries that remain after surface mining operations. Most pits are filled with water, and the open quarries contain some water part of the year (fig. 12). Areas range from 2 to 20 acres in size.

Included with this unit in mapping are small areas of dumps. Dumps are strongly sloping to steep, well drained mixtures of shale, sandstone, limestone, and the original mantle of soil material that has been radically altered by mining operations. Dumps surround the edges of the pits or quarries and make up about 20 percent of the unit.

Steep slopes, large stones, and the exposed rock restrict use. Almost no vegetation can be produced. Most pits can be developed into a source of water for wildlife, irrigation, or livestock. The surface quarries are typically open at one end and do not contain enough water to be economically important. The smaller pits and quarries can be reclaimed to produce an adequate plant cover with a minimum investment. As the size and intensity of mining operations increase, the difficulty of reclamation and the investment required increase.

The included dumps are suited to grasses and legumes for pasture if they are leveled and shaped before seeding. Management that maintains an adequate plant cover for ground mulch helps to prevent excessive soil loss and improves moisture supplying capacity by reducing runoff. Overstocking and overgrazing the pasture reduce the protective plant cover and cause deterioration of the plant community. Planned grazing that maintains proper stocking, uniform grazing distribution, and timely deferment of grazing help to keep the pasture and soil in good condition.

This unit is generally not suited to building site development and sanitary facilities. Some pits and quarries have potential as sanitary landfills, but onsite investigation is needed.

This unit is not assigned to a capability group or woodland ordination group.

PoB—Polo silt loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops and the upper parts of side slopes. Areas are irregular in shape and range from 5 to 160 acres.

Figure 12.—Pits, quarries, filled with water and used for fishing and swimming.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 66 inches thick. The upper part is very dark grayish brown silty clay loam; the middle part is dark brown and dark yellowish brown silty clay loam; and the lower part is reddish brown, friable silty clay loam. In places, the subsoil contains a few gray mottles at a depth of about 42 inches. In some areas, the surface layer has been mixed with the upper part of the subsoil by plowing and is silty clay loam.

Included with this soil in mapping are small areas of moderately well drained Sharpsburg soils and somewhat poorly drained Macksburg soils. These soils are in nearly level areas where the ridgetop is broader. Also included are small areas of somewhat poorly drained Sampsel soils and moderately well drained Deepwater soils. Sampsel soils are in shallow depressions and at the heads of drainageways. Deepwater soils are in areas where the underlying material changes from limestone to shale. These included soils make up 5 to 15 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff is medium in this Polo soil. Reaction ranges from medium acid to very strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are high. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is fair for sanitary facilities and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas, there are slopes that are long enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to grasses and legumes for pasture and hay. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the high shrink-swell potential. If proper design and installation procedures are used, this soil is suited to onsite waste disposal. Excessive seepage from sewage lagoons can be prevented by sealing the bottom. The soil does not have sufficient strength and stability to support vehicular traffic. This limitation can overcome by replacing the surface layer with suitable base material.

This soil is in capability subclass IIe. It is not assigned to a woodland ordination group.

PoC2—Polo silt loam, 5 to 9 percent slopes, eroded. This moderately sloping, well drained soil is on convex side slopes and some of the steeper ridgetops where erosion has occurred. Areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is about 66 inches thick. The upper part is very dark grayish brown, friable silty clay loam, and the lower part is brown and dark brown, firm silty clay loam. In places, the subsoil contains a few gray mottles at a depth of about 42 inches. In some areas, the surface layer has been mixed with the upper part of the subsoil by plowing and is silty clay loam. In some small areas, subsoil material is exposed at the surface as a result of erosion.

Included with this soil in mapping are small areas of somewhat poorly drained Sampsel soils and moderately well drained Snead and Deepwater soils. Snead soils are in areas where limestone and shale bedrock is at or near the surface. Sampsel soils are at the heads of small drainageways where water accumulates. Deepwater soils are in areas where the underlying material changes from limestone to shale. These included soils make up 5 to 15 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff is medium in this Polo soil. Reaction is strongly acid or medium acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are high, except in areas where the surface layer has been removed by erosion. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle after hard rains in areas where there are sufficient amounts of subsoil material.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is fair for sanitary facilities and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of further erosion. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas, slopes are long and even enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

This soil is suited to grasses and legumes for pasture and hay. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil

loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the high shrink-swell potential of the soil. Onsite waste disposal can be handled by properly designed septic tanks. Sewage lagoons in the less sloping areas can be designed to operate properly if excessive seepage is prevented by sealing the bottom. This soil does not have sufficient strength and stability to support vehicular traffic. This limitation can be overcome by replacing the surface layer with suitable base material.

This soil is in capability subclass IIIe. It is not assigned to a woodland ordination group.

SaB—Sampsel silty clay loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on convex ridgetops and narrow ridge points. Areas are regular in shape and range from 20 to 320 acres.

Typically, the surface layer is black silty clay loam about 11 inches thick. The subsoil is about 65 inches thick. The upper part is black, mottled, firm silty clay loam; the middle part is dark gray, very firm, mottled silty clay; and the lower part is dark gray and grayish brown, firm, mottled silty clay loam. In some areas, the subsoil is thicker and in some areas the surface layer is thicker. In some eroded areas, the surface layer has been mixed with the upper part of the subsoil and is silty clay. In some small areas, slope is steeper.

Included with this soil in mapping are small areas of somewhat poorly drained Macksburg soil and moderately well drained Deepwater soil. The Macksburg soil is in areas where the ridgetop becomes broader, and the Deepwater soil is on the more sloping ridge points and slope breaks. These included soils make up about 5 percent of the unit.

Permeabilty is slow, available water capacity is moderate, and surface runoff from cultivated areas is medium in this Sampsel soil. This soil is saturated with water during some periods in most years. Reaction ranges from mildly alkaline to medium acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are high. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle after hard rains, especially in areas where the surface layer contains subsoil material.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is poor for trees, sanitary facilities, and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of soil as pastureland or hayland effectively controls erosion and improves soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to woodland or openland wildlife habitat. Field borders, hedgerow plantings, and areas of mixed grasses and legumes provide food and cover that encourage nesting and support large populations of wildlife.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soil from becoming saturated. Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. Onsite waste disposal can be handled by properly designed sewage lagoons.

This soil is in capability subclass IIe. It is not assigned to a woodland ordination group.

SaC—Sampsel silty clay loam, 5 to 9 percent slopes. This moderately sloping, somewhat poorly drained soil is on convex side slopes. Areas are irregular in shape and range from 5 to 115 acres.

Typically, the surface layer is black, friable silty clay loam about 13 inches thick. The subsoil is about 47 inches thick. The upper part is black, firm, mottled silty clay loam; the middle part is dark gray, very firm, mottled silty clay; and the lower part is dark gray and dark grayish brown, very firm, mottled silty clay. In places, the subsoil is thicker. In a few areas, the subsoil is not so fine textured and the surface layer is silt loam. In eroded areas the surface layer contains subsoil material.

Included with this soil in mapping are a few small areas of somewhat poorly drained Macksburg soils and moderately well drained Snead soils. Macksburg soils are along the upper parts of side slopes where the loess extends onto the slopes. Snead soils typically are on the lower parts of side slopes below Sampsel soils, but they also are higher on the slopes if limestone and shale bedrock is at or near the surface. These included soils make up about 15 percent of the unit.

Permeability is slow, available water capacity is moderate, and surface runoff from cultivated areas is medium in this Sampsel soil. This soil is saturated with water during some period in most years, and in some places seepy spots stay wet for long periods. Reaction ranges from mildly alkaline to medium acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are high. The surface layer is friable and is easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle after hard rains, however, especially in areas where the surface layer contains subsoil material.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is poor for trees, sanitary facilities, and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas, slopes are long and smooth enough to be terraced and farmed on the contour. In seepy areas, tillage may be delayed and yields reduced by wetness. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of this soil as pastureland or hayland effectively controls erosion and improves soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to woodland or openland wildlife habitat. Field borders, hedgerow plantings, and areas of mixed grasses and legumes provide food and cover that encourages nesting and supports large populations of wildlife.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soil from becoming saturated. Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. Sewage lagoons can be used for onsite waste disposal if they are in some of the less sloping areas or on foot slopes.

This soil is in capability subclass IIIe. It is not assigned to a woodland ordination group.

SaC3—Sampsel silty clay loam, 5 to 9 percent slopes, severely eroded. This moderately sloping, somewhat poorly drained soil is on convex side slopes. Areas are regular in shape and range from 4 to 90 acres.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsoil is about 49 inches thick. The upper part is black, firm, mottled silty clay loam; the middle part is gray, very firm, mottled silty clay; and the lower part is brown, very firm, mottled silty clay. The substratum to a depth of 60 inches or more is gray and strong brown, calcareous, mottled silty clay. In places, the subsoil is thicker. In other places, the surface layer is thicker. In some areas where erosion has removed most of the silty clay loam, the surface layer is silty clay. In other areas, gullies caused by excess runoff are 60 inches or more deep and limestone and shale bedrock is at or near the surface.

Included with this soil in mapping are small areas of somewhat poorly drained Macksburg soils and moderately well drained Snead soils. Macksburg soils are along the upper parts of side slopes where irregular ridge points extend onto the slopes. Snead soils typically are on the lower parts of side slopes below Sampsel soils but also are higher on the slope if limestone and shale is at or near the surface. These included soils make up about 15 percent of the area.

Permeability is slow, available water capacity is moderate, and surface runoff from cultivated areas is medium in this Sampsel soil. This soil is saturated with water during some period in most years, and in some places seepy spots stay wet for long periods. Because of the uneven flow of water, some areas tend to remain wet long after the majority of the soil has dried out. Reaction ranges from mildly alkaline to medium acid in the subsoil and varies in the surface layer as a result of liming. Natural fertility and organic matter content are mainly medium, except in less eroded areas where more of the surface layer remains. The surface layer is firm and slightly plastic during wet periods. Tillage generally is delayed by wetness. The soil tends to crust or puddle after hard rains, and it tends to form large clods when tilled during periods of high moisture content.

All but the most severely eroded and gullied areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is poor for trees, sanitary facilities, and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of further erosion. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas, slopes are long and smooth enough to be terraced and farmed on the contour. In seepy areas, tillage may be delayed and yields reduced by wetness. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion and improves soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to woodland or openland wildlife. Field borders, hedgerow plantings, and areas of mixed grasses and legumes provide food and cover that encourage nesting and support large populations of wildlife.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the shrinking and swelling of the soil. Artificial drainage is needed around buildings to keep the soil from becoming saturated. Local roads should be graded to shed water, and suitable base material needs to be hauled in from another location. Sewage lagoons can be used for onsite waste disposal if they are constructed in the less sloping areas.

This soil is in capability subclass IIIe. It is not assigned to a woodland ordination group.

ShB—Sharpsburg silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex ridgetops and upland divides. Areas are round and range from 2 to 60 acres.

Typically, the surface layer is very dark grayish brown and very dark brown silt loam about 10 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 36 inches thick. The upper part is dark brown, firm silty clay loam; the middle part is dark yellowish brown, firm, mottled silty clay loam; and the lower part is grayish brown, firm, mottled silty clay loam. The substratum to a depth of 60 inches or more is yellowish brown and grayish brown, mottled silty clay loam. In places, the soil is slightly darker, has a finer textured subsoil, and is somewhat poorly drained. In some eroded areas, the surface layer contains subsoil material. In a few areas, the soil is well drained and not so fine textured.

Included with this soil in mapping are a few small areas of somewhat poorly drained Macksburg soil and well drained Polo soil. Macksburg silt loam is in shallow depressions, and Polo silt loam is on the higher ridgetops. These included soils make up about 10 percent of the area.

Permeability is moderately slow, available water capacity is high, and surface runoff from cultivated areas is medium in this Sharpsburg soil. Reaction ranges from medium acid to strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural fertility and organic matter content are high. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle after hard rains, however, especially in areas where the surface layer contains subsoil material.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is poor to fair for most engineering uses.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help prevent excessive soil loss. In a few areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of this soil as pastureland or hayland effectively controls erosion and improves soil fertility. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

The soil is well suited to openland or woodland wildlife. Field borders, hedgerow plantings, and areas of mixed grasses or legumes for food near wildlife cover encourage larger populations of wildlife.

This soil is suited to building site development if foundations and footings are designed to prevent structural damage caused by the shrinking and swelling of the soil. Local roads need to be graded to shed water, and suitable base material needs to be hauled in from another location. Sewage lagoons can be used for onsite waste disposal.

This soil is in capability subclass IIe and woodland ordination group 4o.

SnD2—Snead silty clay loam, 7 to 16 percent slopes, eroded. This moderately sloping and strongly sloping, moderately well drained soil is on convex side slopes. Areas are irregular in shape and range from 6 to 80 acres.

Typically, the surface layer is very dark brown, very friable silty clay loam about 2 inches thick. The subsurface layer is black, friable silty clay loam about 6 inches thick. The subsoil is about 15 inches thick. The upper part is very dark grayish brown, firm silty clay, and the lower part is dark grayish brown, firm, mottled silty clay. The substratum to a depth of about 44 inches is light olive brown, mottled, calcareous shale that has seams of silty clay loam. To a depth of 46 inches or more, the substratum is soft, thinly layered shale bedrock. In some areas, flat limestone rocks are scattered throughout the surface layer. In a few areas, thin layers of limestone bedrock are at or near the surface. In small areas, the slope is less than 7 percent, and in some areas it is more than 16 percent.

Included with this soil in mapping are small areas of deep, well drained Polo soils and deep, somewhat poorly drained Sampsel soils. Polo soils are on higher, convex areas of the landscape. Sampsel soils are just above or just below this Snead soil. These included soils make up less than 10 percent of the unit.

Permeability is slow, and available water capacity is low in this Snead soil. Surface runoff from pasture and from timbered areas is medium to rapid. Organic matter content is high, and natural fertility is moderately high.

Reaction ranges from neutral to moderately alkaline in the subsoil, and free carbonates are common in the lower part of the subsoil and in the substratum. The surface layer typically is slightly acid or neutral, but reaction varies according to the depth to limestone. The shrink-swell potential is high. Root development is restricted below a depth of about 15 to 30 inches by limestone and shale bedrock.

About half of the acreage of this soil is planted to grass for pasture and hay, and the rest is in poor quality timber and shrubs. The potential is fair for pasture and hayland, but it is poor for cultivated crops and trees and for sanitary facilities and building site development.

This soil is suited to grasses for hay and pasture. If the soil is cultivated, there is a hazard of severe erosion damage as a result of the steep slopes. The low available water capacity and steepness of slopes are limitations. Returning residue to the soil or the regular addition of other organic material helps to improve fertility and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to some trees, and some areas remain in native hardwoods. Despite the shallow rooting depth caused by the limestone flagstones and bedrock, native black walnut grows on this soil. Harvestable logs and nut crops can be grown. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation; by prescribed burning; or by spraying, cutting, or girdling. If possible, logging roads and skid trails should be constructed on the contour to prevent the formation of gullies.

This soil is generally not suited to building site development or onsite waste disposal. The steepness of slope, high shrink-swell potential, and depth to shale bedrock or thin layers of limestone bedrock are limitations to buildings. This soil does not support buildings or retaining walls. The slow permeability is a limitation to the construction of local roads or streets.

This soil is in capability subclass VIe. It is not assigned to a woodland ordination group.

SoD—Snead-Rock outcrop complex, 5 to 14 percent slopes. This complex consists of the moderately sloping and strongly sloping, moderately well drained Snead soil and Rock outcrop. It is on convex side slopes. Areas are rectangular and range from 3 to 184 acres. The complex is 85 percent Snead soil and 15 percent limestone Rock outcrop. The Snead soil is on convex middle and lower parts of side slopes. Rock outcrop typically is on the upper parts of side slopes but can be anywhere on the slope. The Snead soil and Rock outcrop are so intricately mixed that it is not practical to map them separately.

Typically, the Snead soil has a surface layer of very dark grayish brown, friable silty clay loam about 5 inches thick. The subsoil is about 19 inches thick. The upper part is very dark grayish brown, friable silty clay, and the lower part is very dark grayish brown and olive gray, very firm, mottled silty clay. The substratum to a depth of about 40 inches or more is mottled olive gray and yellowish brown shale and silty clay loam. In places, the soil is flaggy throughout and bedrock is at a depth of 20 to 40 inches. In places the soil is more than 40 inches thick over bedded shale, and in places the surface layer is lighter colored.

Typically, Rock outcrop consists of thin to thick beds of limestone. In some places, it forms ledges, and in other places, it is gently sloping or smooth. In places, Rock outcrop has a thin covering of soil. A few limestone boulders occur where the limestone ledge has broken and a large rock has fallen downslope.

Included in mapping are small areas of well drained Polo soil and somewhat poorly drained Sampsel soil. Polo silt loam is on the upper parts of slopes, and it varies in thickness according to the thickness of the limestone ledge. Sampsel silty clay loam is just above or just below this Snead soil. These included soils make up less than 10 percent of the complex.

Permeability is slow, and available water capacity is low in this complex. Surface runoff from pasture and from timbered areas is medium to rapid. Organic matter content is high, and natural fertility is medium. Reaction ranges from neutral to moderately alkaline in the subsoil. The shrink-swell potential in the subsoil is high. Root development is restricted below a depth of about 24 inches by shale and limestone bedrock.

The acreage of this complex is nearly equally pasture and forest. The potential is poor for cultivated crops, grasses, legumes, trees, sanitary facilities, and building site development.

The soil in this complex is best suited to pasture. Major concerns of pasture management are related to the hazard of erosion and low available water supply. The soil in this complex tends to be droughty because of low available water capacity and water loss from runoff. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

The soil is poorly suited to trees because limestone and shale bedrock are near the surface. Some areas, however, remain in native hardwoods. Despite the shallow rooting depth, native black walnut grows on the soil

in this complex. Some harvestable logs and nut crops can be grown. Logging roads and skid trails should be constructed on the contour.

This soil generally is not suitable for building site development and onsite waste disposal. The large stones, wetness, and depth to limestone and shale bedrock are limitations.

This complex is in capability subclass VIe. It is not assigned to a woodland ordination group.

SoF—Snead-Rock outcrop complex, 14 to 35 percent slopes. This complex consists of the moderately steep and steep, moderately well drained Snead soil and Rock outcrop. It is on convex side slopes. Areas range from 20 to 180 acres. The complex is 80 percent Snead soil and 20 percent limestone rock outcrop. The Snead soil is on convex, middle and lower parts of side slopes; Rock outcrop typically is on the upper parts of side slopes but can be anywhere on the slope. The Snead soil and Rock outcrop are so intricately mixed that it is not practical to map them separately.

Typically, the Snead soil has a silty clay loam surface layer about 3 inches thick. The subsoil is about 18 inches thick. The upper part is very dark brown, very firm silty clay, and the lower part is olive gray, very firm, mottled silty clay. The substratum to a depth of 44 inches or more is brownish yellow and grayish brown, mottled, calcareous shale that has silty clay along cracks and seams. In places, the soil is flaggy throughout and limestone bedrock is at a depth of 20 to 40 inches. In some places the soil is more than 45 inches thick over bedded shale, and in places the surface layer is lighter colored.

Typically, Rock outcrop consists of thin to thick beds of limestone that crop out at the surface. In places, it forms ledges, and in others it is nearly level or sloping. In places, the Rock outcrop is covered with 5 to 20 inches of soil. A few limestone boulders occur where the limestone ledge has broken and a large rock has fallen downslope.

Included in mapping are small areas of well drained Norris soils and somewhat poorly drained Sampsel soils. Norris soils are in areas where trees have affected soil development, and Sampsel soils are in areas that are more than 40 inches thick over shale bedrock. These included soils make up about 15 percent of the complex.

Permeability is slow, surface runoff is rapid, and available water capacity is low in this complex. Organic matter content is high. Reaction ranges from neutral to moderately alkaline in the subsoil. Free carbonates are in the lower part of the subsoil and around the Rock outcrop. The surface layer is slightly acid or neutral in the Snead soil. Natural fertility is medium. The shrink-swell potential is high. Root development is restricted at a depth of 32 inches or less by limestone and shale bedrock.

Most areas of this complex are used for hardwood forest. The potential is poor for trees, cultivated crops, grasses, and legumes. It is also poor for sanitary facilities and building site development.

Trees grow slowly and generally start to rot or develop hollow places before they reach a harvestable size. Some areas are suited to harvestable trees, however. If trees are grown, the slope aspect should determine the site. Logging roads and skid trails should be constructed on the contour.

The soil in this complex can be used for pasture. Major concerns of pasture management are related to the hazard of erosion and the low available water supply. The soil tends to be droughty as a result of the low available water capacity and the water loss caused by runoff. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil loss and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing pasture reduce the protective plant cover and cause deterioration of the plant community. Proper stocking, uniform grazing distribution, timely deferment of grazing, and planned grazing help to keep the pasture and soil in good condition.

This soil generally is not suitable for building site development and onsite waste disposal. Slope, wetness, and the depth to limestone and shale bedrock are limitations.

This complex is in capability subclass VIe. It is not assigned to a woodland ordination group.

Wa—Wabash silty clay. This nearly level, very poorly drained soil is in large depressions of flood plains. Areas are irregular in shape and range from 10 to 120 acres. Most areas of this soil are flooded frequently.

Typically, the surface layer is black, firm silty clay about 7 inches thick. The subsurface layer is black, very firm silty clay about 8 inches thick. The subsoil is black, very firm silty clay about 36 inches thick. The substratum to a depth of 66 inches or more is black, very firm silty clay. In some areas, the surface layer is silty clay loam. Some areas have 6 to 12 inches of silt loam overwash.

Included with this soil in mapping are small areas of somewhat poorly drained Dockery soils and poorly drained Zook soils. These included soils are closer to the main stream channel than this Wabash soil. They make up 5 to 10 percent of the unit.

Permeability is very slow, available water capacity is medium, and surface runoff is very slow in the Wabash soil. Reaction ranges from mildly alkaline to slightly acid throughout. Natural fertility and organic matter content are high. Because the surface layer is firm and clayey, tillage must be carefully timed. Field operations during periods of high moisture content cause the soil to form large clods that are difficult to break down. Root development is restricted below a depth of 12 to 36 inches as a result of a high water table.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is poor for sanitary facilities and building site development.

This soil is suited to corn, soybeans, grain sorghum, and grasses. If the soil is cultivated, flooding and wetness are hazards. Artificial drainage and timely tillage help to overcome these limitations. Several methods of artificial drainage and flood protection can be used successfully.

This soil produces high quality grass for hay and pasture if water-tolerant species are used. Restricted use during wet periods helps to keep the pasture and soil in good condition and helps to avoid surface compaction.

The Wabash soil is suited to wetland wildlife. Shallow water impoundments and water-tolerant species of perennial plants for food and cover attract wetland wildlife.

This soil generally is not suited to building site development and waste disposal systems. Building sites should be artificially drained and protected from flooding. Dwellings and small buildings need to be constructed without basements, and foundations and footings need to be designed to prevent structural damage caused by the shrinking and swelling of the soil. All sanitary facilities should be connected to commercial sewers and treatment facilities. Wetness, the shrink-swell potential, and low strength make this soil a poor source of roadfill.

This soil is in capability subclass IIIw and woodland ordination group 4w.

WdB—Weller silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on ridgetops and rounded ridge points. Areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is dark grayish brown and brown, very friable silt loam about 12 inches thick. The subsurface layer is grayish brown, very friable silty clay loam about 4 inches thick. The subsoil is about 60 inches or more thick. The upper part is brown, friable silty clay loam; the middle part is brown, very firm, mottled silty clay; and the lower part is grayish brown, mottled silty clay loam. In places, the subsoil is finer textured. In some eroded areas, the surface layer has been mixed with the subsoil and is silty clay loam. In a few areas, the surface layer is thin and very dark grayish brown.

Included with this soil in mapping are small areas of somewhat poorly drained Macksburg soils and moderately well drained Winfield soils. The Macksburg soils are in areas where the ridgetop becomes larger and broader. The Winfield soils are on narrow, more sloping ridge points. These included soils make up about 5 percent of this unit.

Permeability is slow, available water capacity is high, and surface runoff is medium in this Weller soil. Reaction ranges from very strongly acid to neutral in the subsoil and from slightly acid to neutral in the surface. Natural fertility is medium, and organic matter content is low to medium. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential in the subsoil is moderate to high.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, and pasture. It is poor for sanitary facilities and building site development.

This soil is suited to corn, soybeans, small grain, grain sorghum, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to building site development if the design prevents structural damage caused by the shrinking and swelling of the soil. Sewage lagoons can be used for onsite waste disposal. Fill material for local streets and roads needs to be hauled in from another location.

This soil is in capability subclass IIe and woodland ordination group 4o.

WfB—Winfield silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex ridgetops. Areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is dark yellowish brown silt loam about 10 inches thick. The subsoil is about 49 inches thick. The upper part is dark yellowish brown, very friable silty clay loam. The lower part is dark brown and brown, friable, mottled silty clay loam. The substratum to a depth of about 75 inches or more is yellowish brown, friable, mottled silty clay loam. In places, the surface layer is thicker. In a few areas, the surface layer is very dark grayish brown. In a few small areas, the subsoil is thinner.

Included with this soil in mapping are small areas of well drained Mandeville soils and moderately well drained Weller soils. The Mandeville soils are on the narrow, more sloping ridge points, and the Weller soils are in the broader, flatter areas of ridgetops. These included soils make up 2 to 8 percent of the unit.

Permeability is moderate. Available water capacity is high, and surface runoff from cultivated areas is medium or rapid in this Winfield soil. Reaction ranges from medium acid to strongly acid in the subsoil and varies widely in the surface layer as a result of liming. Natural

fertility is moderate to high, and organic matter content is medium. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. It tends to erode easily, however.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to good for sanitary facilities and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In a few areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees, and a few small areas remain in native hardwoods. There are no hazards or limitations to planting or harvesting trees.

This soil is well suited to woodland or openland wildlife habitat. It is well suited to grain and seed crops, grasses, legumes, wild herbaceous plants, and hardwood and coniferous trees. This habitat provides excellent cover and the food needed for a large and thriving wildlife population.

This soil is suited to building site development and onsite waste disposal systems if proper design and installation procedures are used. It does not have sufficient strength and stability to support vehicular traffic, but this limitation can be corrected by strengthening or replacing the base material. The moderate shrink-swell potential is a limitation to building site development, but this limitation can be overcome by proper design. Sewage lagoons can be used for onsite waste disposal. Excess seepage can be controlled by sealing the bottom of the lagoon.

This soil is in capability subclass IIe and woodland ordination group 3o.

WfC—Winfield silt loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on convex side slopes. Areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is brown and dark grayish brown silt loam about 8 inches thick. The subsoil is about 70 inches thick. The upper part is yellowish brown, very friable silty clay loam; the middle part is dark yellowish brown and dark brown, firm, mottled silty clay loam; and the lower part is strong brown, firm, mottled silty clay loam. In places, the subsoil is thinner. In a few eroded areas, the surface layer has been completely eroded and is silty clay loam. In places, the surface layer is very dark grayish brown silt loam about 4 inches thick.

Included with this soil in mapping are small areas of moderately well drained Weller soils and well drained Mandeville soils. The Weller soils are on the ridgetops and upper parts of side slopes, and the Mandeville soils are on the lower parts of side slopes and foot slopes where the loess mantle is thinner. These included soils make up about 10 percent of the unit.

Permeability is moderate, available water capacity is high, and surface runoff from cultivated areas is medium to rapid in this Winfield soil. Reaction ranges from slightly acid to strongly acid in the subsoil and varies in the surface layer as a result of liming. Natural fertility and organic matter content are medium. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. It tends to erode easily, however.

Most areas of this soil are farmed. The potential is fair for cultivated crops and good for hay, pasture, and trees. It is fair to good for sanitary facilities and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of the soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees, and a few small areas remain in native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation; by prescribed burning; or by spraying, cutting, or girdling. There are no hazards or limitations to planting or harvesting trees.

This soil is suited to upland or woodland wildlife habitat. Field borders, hedgerow plantings, and areas of mixed grasses and legumes provide food and cover that encourage nesting and support large populations of wildlife.

This soil is suited to building site development and onsite waste disposal systems if proper design and installation procedures are used. It does not have sufficient strength and stability to support vehicular traffic,

but this limitation can be corrected by strengthening or replacing the base material. The moderate shrink-swell potential is a limitation to building site development, but this limitation can be overcome by proper design. For onsite waste disposal, sewage lagoons can be located in the less sloping areas. Excess seepage can be controlled by sealing the bottom of the lagoon.

This soil is in capability subclass IIIe and woodland ordination group 3o.

WfC3—Winfield silty clay loam, 5 to 9 percent slopes, severely eroded. This moderately sloping, moderately well drained soil is on convex side slopes. Areas are irregular in shape and range from 6 to 80 acres.

Typically, the surface layer is dark brown and very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is about 23 inches thick. It is yellowish brown, mottled silty clay loam; the upper part is firm, and the lower part is friable. The substratum to a depth of 50 inches is yellowish brown, friable, mottled silty clay loam. To a depth of about 70 inches or more, the substratum is pale brown, firm, mottled silty clay. In places, the surface layer is thicker. In places, gullies have been cut to a depth of 15 feet (fig. 13). Depth to bedrock is shallower in some places.

Figure 13.—A severely eroded area of Winfield silty clay loam.

Included with this soil in mapping are small areas of moderately well drained Weller and Mandeville soils. The Weller soils are on the narrow ridgetops and upper parts of side slopes, and the Mandeville soils are on the lower parts of side slopes and foot slopes where the loess mantle is thinner. These included soils make up about 15 percent of the unit.

Permeability is moderate, available water capacity is medium, and surface runoff from cultivated areas is medium to rapid in this Winfield soil. Reaction ranges from medium acid to strongly acid in the subsoil and varies in the surface layer as a result of liming. Natural fertility is medium, but organic matter content is low as a result of the loss of soil from the surface by erosion. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. The soil is deep, but it is subject to continued severe erosion unless control measures are maintained.

Most areas of this soil are farmed. The potential is fair for cultivated crops and good for hay, pasture, and trees. It is fair to good for sanitary facilities and building site development.

This soil is suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. If the soil is cultivated, there is a hazard of further erosion damage. Minimum tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas, slopes are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or the regular addition of other organic material helps to improve fertility, reduce crusting, and increase water infiltration.

The use of this soil as pastureland or hayland effectively controls erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees, and a few small areas remain in native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed by site preparation; by prescribed burning; or by spraying, cutting, or girdling. There are no major hazards to planting or harvesting trees.

This soil is suited to upland or woodland wildlife habitat. Field borders, hedgerow plantings, areas of mixed grasses and legumes, and stabilization of gullied areas with trees and cover crops provide cover and food that encourage nesting and support large populations of wildlife.

This soil is suitable for building site development and onsite waste disposal systems if proper design and installation procedures are used. It does not have sufficient strength and stability to support vehicular traffic, but this limitation can be corrected by strengthening or replacing the base material. The moderate shrink-swell potential of the soil is a limitation to building site development, but this limitation can be overcome by proper design. For onsite waste disposal, sewage lagoons should be located in the less sloping areas. Excess seepage can be controlled by sealing the bottom of the lagoon.

This soil is in capability subclass IIIe and woodland ordination group 3o.

Zk—Zook silty clay loam. This nearly level, poorly drained soil is in slightly depressional areas of large bottom lands and narrower stream valleys of smaller streams. Areas are irregular in shape and range from 5 to 100 acres. Most areas of this soil are flooded frequently.

Typically, the surface layer is very dark gray silty clay loam about 15 inches thick. The subsurface layer is very dark gray, firm silty clay loam about 7 inches thick. The subsoil is very dark gray, firm silty clay about 38 inches thick. In some areas, the surface layer is thinner. Some places have 5 to 12 inches of brown silt loam overwash.

Included with this soil in mapping are small areas of finer textured Wabash soils in depressions and moderately well drained Nodaway soils along stream channels. These included soils make up 5 to 15 percent of the unit.

Permeability is slow, available water capacity is high, and runoff is slow to very slow in this Zook soil. Reaction ranges from mildly alkaline to medium acid. Natural fertility and organic matter content are high. The surface layer is firm, and tillage should be timed carefully. Field operations during periods of high moisture content cause the soil to form large clods that are difficult to break down. Root development is restricted below a depth of 12 to 36 inches because of a high water table.

Most areas of this soil are farmed (fig 14). The potential is good for cultivated crops, hay, pasture, and wildlife habitat. It is poor for sanitary facilities and building site development.

This soil is suited to corn, soybeans, grain sorghum, small grain, and grasses for hay and pasture. If this soil is cultivated, yields are lowered by water standing in potholes and by flooding. Artificial drainage and timeliness of tillage help to increase yields.

This soil produces high quality grass for hay and pasture if water-tolerant species are selected. Restricted use during wet periods helps to keep the pasture and soil in good condition and avoid surface compaction.

This soil is well suited to wetland wildlife. It is suited to wetland vegetation for food and cover and to shallow water impoundments. Openland wildlife can be encouraged by creating a maximum of interspersion of fields in which grain and seed crops are available for food and border cover for protection.

This soil is generally not suited to building sites and water disposal systems because of flooding and wetness.

Figure 14.—Corn on Zook silty clay loam.

This soil is in capability subclass IIw. It is not assigned to a woodland ordination group.

Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on

soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and pasture

George Hays, district conservationist, Soil Conservation Service, assisted in writing this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Soil maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 400,000 acres in the survey area was used for crops and pasture in 1970, according to the Conservation Needs Inventory (*15*). Of this total, 125,000 acres was used for permanent pasture; 110,000 acres for row crops; 21,000 acres for close grown crops, mainly wheat; 15,000 acres for rotation hay and pasture; and the rest was idle cropland and formerly cropped openland.

The soils in Johnson County have good potential for increased production of food. About 31,000 acres of potentially good cropland is used as woodland and about 80,000 acres is used as pasture. In addition to the reserve productive capacity represented by this land, food production could also be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

The acreage used for cropland has been gradually increasing as more pasture and hayland is used for row crop production. There also has been an increase of urban development in the northwestern part of the county and around the major towns. In 1970 there was an estimated 16,000 acres of urban and built-up land in the county. This figure has been increasing at a rate of about 500 acres per year. The use of this soil survey to help make land use decisions that will influence the future role of farming in the county is discussed in the section, "General soil map for broad land use planning."

Soil erosion is the major concern on about two-thirds of the cropland and pasture in Johnson County. If the slope is more than 2 percent, erosion is a hazard. Sampsel, Macksburg, and Hartwell soils, for example, have slopes of more than 2 percent. Wetness is also a concern.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Hartwell and Sampsel soils, and soils that have a layer below the subsoil that limits the depth of the root zone. Such layers include bedrock as in Barco, Bolivar, Mandeville, Norris, and Snead soils. Erosion also reduces productivity on soils that tend to be droughty, such as the Snead-Rock outcrop complex. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, recreation, and fish and wildlife.

In many sloping fields, preparing a good seedbed and tilling are difficult on clayey or shaly spots because the original, friable surface layer has been eroded away. Such spots are common in moderately eroded Sampsel and Mandeville soils.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration (fig. 15). A cropping system that keeps vegetative cover on the soil for extended periods can hold soil erosion losses to amounts that do not reduce the productive capacity of soils. On livestock farms which require pasture and hay, the legume and grass forage crops reduce erosion on sloping land and also provide nitrogen and improve tilth for the following crops.

The slopes are shaped on most soils so that waterways and terraces can be built. Terracing is not practical on Snead, Norris, Mandeville, Bolivar, and Barco soils. On these soils, a cropping system that provides substantial vegetative cover is needed to control erosion, unless minimum tillage is practiced. Minimizing tillage and leaving crop residue on the surface help to increase infiltration and reduce the hazards of runoff and erosion. These practices can be adapted to most soils in the survey

Figure 15.—Macksburg and Sampsel soils with terraces.

area but are more difficult to use successfully on the eroded soils and on the soils that have a clayey surface layer, such as Wabash and Zook soils. No-tillage for corn, which is increasingly common, reduces erosion on sloping land and can be adapted to most soils in the survey area. No-tillage however, is more difficult to practice successfully on soils that have a clayey surface layer.

Terraces and diversions reduce the length of slope and reduce runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. Deepwater and Polo soils are suitable for terraces. Other soils are less suited to terraces, but terrace channels and waterways help to drain wet soils, such as Sampsel soils, and make them easier to farm. A clayey subsoil which would be exposed in terrace channels or bedrock at a depth of less than 40 inches, reduces the suitability for terraces on other soils.

Soil blowing is a hazard on Haig, Macksburg, Deepwater, Polo, Hartwell, and Sharpsburg soils if they are left bare in winter and early in spring. Soil blowing can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining vegetative cover, surface mulch, or rough surfaces through proper tillage minimizes soil blowing on these soils.

Soil drainage is the major management need on about 30,000 acres of cropland in the survey area. Some soils are naturally so wet that the production of crops common to the area is generally not possible. These are somewhat poorly drained Dockery and Lightning soils; poorly drained Bremer, Blackoar, and Zook soils; and very poorly drained Wabash soils. These soils make up about 27,000 acres of the survey area.

Unless artificially drained and protected from flooding, the Blackoar, Dockery, Wabash, and Zook soils are so wet that crops are damaged during most years.

Sampsel, Weller, and Higginsville soils have good natural drainage most of the year, but they tend to dry out slowly after rains. Small areas of wet hillside seeps are included in the mapping of these soils. Tile drains for the seepy areas improve these soils for farming and act as outlets for terraces.

Haig, Macksburg, and Hartwell soils are on broad ridgetop divides where slow runoff causes wetness after rains. These soils are slow to dry out in spring; therefore, tillage operations are delayed most years.

The moderate rainfall is adequate for crops and pasture in many years, but summer droughts of sufficient severity and duration are common and reduce crop yields. Crops and pasture grasses grown on shallow and moderately deep soils, such as Kanima, Norris, Snead, Barco, Bolivar, and Mandeville soils, suffer severely from summer drought most years. Hartwell, Gorin, and Lightning soils are less susceptible to drought. Yields are lowered by drought on these deep soils but not as much as on the shallow and moderately deep soils. Deep soils produce crops and pasture most years, and yields are not reduced by droughts of short duration.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Soil maps for detailed planning."

Woodland management and productivity

Gary R. Nordstrom, forester, Soil Conservation Service, assisted in writing this section.

In 1972 about 54,100 acres (*10*), or 10 percent of Johnson County, was used for trees. This represents a loss of 22,600 acres since 1959, when there was 76,700 acres of forest land. The conversion of woodland to cropland and pasture is the main reason for this decrease. The wooded tracts are owned by private individuals and are relatively small. Timber production, recreation, and wildlife habitat are the main uses of woodland. There are several Christmas tree plantations in Johnson County.

Approximately 600,000 board feet are harvested annually in Johnson County. The products produced are saw logs, veneer logs, cooperage logs, posts, and fuel wood.

The Mandeville-Norris-Bolivar association contains the largest percentage of upland hardwood. The principal forest type is upland oak, consisting of white oak, black oak, northern red oak, hickory, post oak, shingle oak, white ash, and a few scattered black walnut. The potential productivity of these soils for trees ranges from fair to poor.

The Sampsel-Snead-Polo association contains scattered tracts of upland hardwood. The potential productivity for trees is fair, except in areas of the Snead soils where potential is poor because of shallowness to bedrock. The principal species present are white oak, black oak, hickory, white ash, and a few scattered black walnut.

The Zook-Dockery-Blackoar association contains the largest percentage of bottomland hardwood. The principal forest type is Elm-Ash-Cottonwood, consisting of eastern cottonwood, American elm, green ash, American sycamore, pin oak, pecan, silver maple, and black walnut. The Nodaway soils, which are a minor component of this association, can produce high quality black walnut logs. The potential productivity for trees is good, except in the Zook soils, where potential is poor because of excessive wetness.

The Macksburg-Sampsel and Sampsel-Deepwater-Haig associations contain only small areas of woodland in draws and along watercourses. The principal species present are American elm, eastern cottonwood, green ash, white ash, northern red oak, white oak, post oak, pin oak, and black walnut. The potential productivity for trees ranges from fair to good.

The site index curves used for the tree species listed in table 7 are as follows: white oak, northern red oak, and black oak (*19*); eastern cottonwood (*6*); pin oak (*7*); black walnut (*12*); pecan (*5*); silver maple (*4*).

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management

or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Engineering

Harry N. Means, assistant state conservation engineer, Soil Conservation Service, assisted in writing this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell

potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features,

and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil

after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Table 12 gives information on the soil properties and site features that affect water management. It gives for each soil the restrictive features that affect pond reservoir areas; embankments, dikes, and levees; drainage; irrigation; terraces and diversions; and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and

grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Recreation

Edward A. Gaskins, biologist, Soil Conservation Service, assisted in the preparation of this section.

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) reports a total of 3,595 acres of existing recreational developments in Johnson County (*20*). The facilities listed include: 21 acres of playfields, 65 acres of fishing waters, 45 acres of boating water, 12 acres suitable for canoe use, 88,120 square feet of swimming area, 222 acres of camping, 4 miles of hiking trails, and 35 acres of picnicking areas. The report projects a minimum county need to increase bike, horse, and hiking trails; hunting areas; and acres of water open to fishing by the year of 1990. The increase would meet the county's future need to provide for a projected increase in total population (41,200) by that date (*9*).

State owned lands open to the public include Knob Noster State Park (3,511 acres) and the Perry Memorial Wildlife Area (1,667 acres). The park offers camping, fishing, swimming, and nature trails to the visitor. The wildlife area offers hunting for openland and woodland game and has waterfowl areas planned for future development.

The NACD Nationwide Outdoor Recreation Inventory lists 13 private and semi-private recreation enterprises in operation within the county (*14*). These consist of three campgrounds, two field sports areas, three commercial fishing areas, a historic site, a picnicking area, a race track, a horseback riding club, and a drive-in theater. The committee which made this inventory felt that water sports areas and vacation farm enterprises were the priority recreation facilities needed in the county.

The soils of the survey area are rated in table 13 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 13, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 13 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife habitat

Edward A. Gaskins, biologist, Soil Conservation Service, assisted in the preparation of this section.

Over 80 percent of Johnson County was classified as prairie at one time. This county is one of the thirteen west-central counties which comprise the West Prairie Zoogeographic Region of Missouri (*17*). Today, approximately 10 percent of the county is classified as woodland. Continued clearing of this wooded base is expected on the more productive agricultural soils during the coming years.

Quail and rabbit populations fluctuate from fair to good in the county depending upon available cover in relation to food supplies. Harvest data shows Johnson County as having one of the larger deer populations in this part of the state. Dove populations, both residents and migratory, are also high. The county has a harvestable population of furbearers. Raccoon are high on the list (*17*). Large populations of various songbirds are found throughout the county. Although several sightings have been reported over the years, prairie chicken and ring-necked pheasant are classified as rare. A release of 3,000 Korean-blackneck cross-hybrid pheasants in neighboring Pettis County is expected (*9*). If the establishment of these birds is successful, they could occupy existing habitat in Johnson County. Waterfowl population is considered low because of the absence of required wetland habitat.

The Macksburg-Sampsel and Zook-Dockery-Blackoar associations are the most intensively cropped of the five associations and comprise approximately 19 percent of the county. Hard (woody) cover is restricted to hedgerows, brushy drainageways, and a few small blocks of woodland in the Macksburg part and in the wooded flood plain (Blackoar part) along the Blackwater River. Clearing of these wooded areas is accelerating, especially on the more productive Macksburg soils.

These soils support a large dove population and in those areas where hard cover remains, are medium quail populations and small to medium rabbit populations. Deer are fairly numerous along the wooded flood plain. Here, too, is found the woodland base needed for squirrel habitat. Cornfields along the border supplement the farily poor oak-hickory mast production. Waterfowl make use of farm ponds for resting during their annual spring migrations. Many old, wooded oxbows, formed during channel work on the Blackwater River, still retain water of varying depths. These areas provide good to excellent habitat for wood duck and other wetland species. Geese from the James A. Reed Wildlife Area in Jackson County feed on agricultural lands in the western part of the county. The state-owned Perry Memorial Wildlife Area is in the Zook-Dockery-Blackoar association near the town of Concordia. This area of 1,667 acres offers upland and forest game hunting to the licensed public.

The Sampsel-Snead-Polo and Sampsel-Deepwater-Haig soil associations comprise around 66 percent of the land area in Johnson County. Farm uses are mainly pasture, hayland, and some cropland. Woody cover is fairly scarce in this large area and is of poorer quality than in other areas. This scarcity of hard cover together with overgrazing of pasture has reduced the capacity of much of this area to support the traditional game species. Medium rabbit populations are still found in the grass-legume hayland areas having brushy cover in close proximity. Coyote hunting is gaining in popularity.

These four associations have the majority of openland habitat in Johnson County.

The Mandeville-Norris-Bolivar soil association, which makes up 15 percent of the county, furnishes the majority of woodland habitat in the county. Knob Noster State Park, which has 3,511 protected acres, provides excellent habitat for various woodland wildlife species. Wild turkey is established in this association; the largest population is on Bristle Ridge near Knob Noster. Squirrel populations range from small to medium depending upon the annual mass production. Small to medium populations of quail, rabbit, and dove can be found in areas where farming has expanded along ridgetops and in narrow valleys that have woody cover well interspersed on the steeper side slopes.

The stream fishery resource is limited to the Blackwater River, the mouth of Post Oak Creek, and parts of Big Creek in the southwestern part of the county. Numerous farm ponds, 68 acres of public waters in Knob Noster Park, a few commercial ponds, and various watershed structures provide opportunities for impoundment type fishing. Principal stream fish are channel catfish, black bullhead, carp, largemouth bass, and other species adapted to the heavily silted, slow moving streams of

this region. Ponds and lakes are normally stocked with largemouth bass, channel catfish, and bluegill.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 14, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, barley, millet, soybeans, and milo.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bluegrass, switchgrass, orchardgrass, indiangrass, clover, trefoil, alfalfa, and crownvetch.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, pokeweed, foxtail, croton, and partridgepea.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, persimmon, sassafras, walnut, and blackhaw.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cutgrass, cattail, rushes, sedges, and buttonbush.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, red fox, woodchuck, and mourning dove.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, deer, and bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 18.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering index properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2, 18*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 18.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward

movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil.

Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and water features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freez-

ing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering index test data

Table 18 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and morphology." The soil samples were tested by the Missouri State Highway Department.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The methods and codes are AASHTO classification (M-145-66); Unified classification (D-2487-66T); mechanical analysis (T88-57); liquid limit (T89-60); plasticity index (T90-56); moisture-density, method A (T99-57); (D-1883).

Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*21*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*22*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

Barco series

This series consists of moderately deep, well drained, moderately permeable soils on narrow upland ridgetops and side slopes. These soils formed in residuum weathered from sandstone and shale. Slopes are 2 to 9 percent.

Barco soils are similar to Bolivar soils and are commonly adjacent to Deepwater and Sampsel soils. Bolivar soils do not have a mollic epipedon. Deepwater soils are moderately well drained, have a finer textured B2t horizon, and are more than 40 inches thick. Sampsel soils are somewhat poorly drained, have a finer textured B2t horizon, and are at the heads of drainageways.

Typical pedon in an area of Barco loam, 5 to 9 percent slopes, 400 feet south and 1,320 feet west of the northwest corner of sec. 22, T. 44 N., R. 29 W.

Ap—0 to 6 inches; dark brown (10YR 3/3) loam; weak fine granular structure; very friable; many fine roots; few small fragments of soft sandstone (less than 10 percent); common worm casts; very strongly acid; abrupt smooth boundary.

B1—6 to 9 inches; dark brown (10YR 3/3) loam; weak fine subangular blocky structure; very friable; many fine roots; few small fragments of soft sandstone (less than 10 percent); common worm casts; very strongly acid; abrupt smooth boundary.

B21t—9 to 12 inches; dark brown (10YR 3/3) loam; weak fine subangular blocky structure; very friable; many fine roots; many fine fragments of soft sandstone (less than 25 percent); common worm casts; very strongly acid; abrupt smooth boundary.

B22t—12 to 18 inches; brown (10YR 4/3) clay loam; weak fine subangular blocky structure; very friable; common fine roots; common fine fragments of soft sandstone (less than 15 percent); common worm casts; strongly acid; clear smooth boundary.

B3t—18 to 34 inches; strong brown (7.5YR 5/6) clay loam; weak fine subangular blocky structure; very friable; few fine roots; common fine fragments of soft sandstone (less than 15 percent); common

worm casts; very strongly acid; clear smooth boundary.

C—34 to 38 inches; yellowish brown (10YR 5/6) clay loam; massive; few fine fragments of soft sandstone (less than 10 percent); strongly acid; abrupt smooth boundary.

Cr1—38 to 52 inches; yellowish brown (10YR 5/6) soft weathered sandstone; plates of light clay loam interbedded along seams (1 centimeter to 2 centimeters thick); strongly acid; clear smooth boundary.

Cr2—52 to 66 inches; pale yellow (2.5Y 7/4) soft rippable strongly acid sandstone.

Thickness of the solum and depth to sandstone range from 20 to 40 inches. Thickness of the mollic epipedon ranges from 10 to 24 inches. Fragments of weathered sandstone comprise less than 35 percent of the soil mass of any horizon.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 2 or 3. It is dominantly loam but ranges to silt loam. The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 through 6. It is loam or clay loam that is 18 to 35 percent clay. The C horizon has hue of 2.5YR, 10YR, 7.5YR, or 5YR; value of 4 through 7; and chroma of 2 through 6. It is clay loam or soft weathered sandstone interbedded with clay loam.

Blackoar series

This series consists of deep, poorly drained, moderately permeable soils on bottom lands. These soils formed in silty alluvium. Slopes are 0 to 2 percent.

Blackoar soils commonly are near Nodaway, Wabash, and Zook soils on the flood plain. Nodaway soils are moderately well drained and are on the natural levees along streams and former channels of streams. Wabash and Zook soils are darker, are finer textured throughout, and are near the uplands where slack water has deposited fine textured material.

Typical pedon in an area of Blackoar silt loam, 400 feet west and 233 feet south of the northeast corner of sec. 12, T. 46 N., R. 26 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; moderate fine granular and subangular blocky structure; very friable; many roots; medium acid; clear smooth boundary.

A12—8 to 22 inches; very dark gray (10YR 3/1) silt loam; weak fine subangular blocky structure; very friable; many roots; medium acid; gradual smooth boundary.

B2g—22 to 43 inches; dark gray (10YR 4/1) silt loam; common fine prominent dark brown (10YR 4/3) and distinct gray (10YR 6/1) mottles; weak very fine subangular blocky structure; very friable; few thin discontinuous clay films; few fine roots; few black concretions; medium acid; diffuse smooth boundary.

Cg—43 to 65 inches; dark gray (10YR 4/1) silt loam, many medium prominent dark brown (10YR 4/3) mottles; weak very fine subangular blocky structure; very friable; few roots; few medium black concretions; medium acid.

Thickness of the solum ranges from 36 to 60 inches. Thickness of the mollic epipedon ranges from 16 to 24 inches. The solum ranges from medium acid to neutral. In some pedons the B horizon has thin layers of silty clay loam. In the matrix of the Bg horizon and Cg horizon, hue is 10YR to 5Y, value is 4 through 6, and chroma is 2 or less.

Bolivar series

This series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in residuum weathered from sandstone and shale. Slopes are 5 to 14 percent.

Bolivar soils are similar to Barco soils and commonly are adjacent to Mandeville and Norris soils. Barco soils have a mollic epipedon that is more than 10 inches thick. Mandeville soils formed in residuum weathered from shale bedrock. Norris soils do not have an argillic horizon and are typically steeper. In addition, the solum is less than 20 inches deep over weathered shale bedrock.

Typical pedon in an area of Bolivar loam, 5 to 9 percent slopes, eroded, 1,220 feet south and 1,480 feet east of the northwest corner of sec. 11, T. 44 N., R. 26 W.

Ap—0 to 4 inches; dark brown (10YR 4/3) loam; weak fine granular structure; very friable; many roots; medium acid; abrupt smooth boundary.

A12—4 to 8 inches; dark brown (10YR 4/3) loam; weak fine granular structure; very friable; many roots; slightly acid; clear smooth boundary.

A2—8 to 11 inches; brown (7.5YR 4/4) loam; weak fine granular structure; very friable; many roots; slightly acid; abrupt smooth boundary.

B1—11 to 14 inches; dark brown (7.5YR 4/4) clay loam; weak fine blocky structure; very friable; many roots; medium acid; few fine sandstone fragments; abrupt smooth boundary.

B2t—14 to 24 inches; yellowish red (5YR 4/6) clay loam; weak fine blocky structure; friable; many fine roots; patchy thin discontinous clay films; common medium sandstone fragments; very strongly acid; abrupt smooth boundary.

B3t—24 to 29 inches; yellowish red (5YR 4/6) clay loam; common medium prominent yellowish brown (10YR 5/8) mottles; weak medium blocky structure; very friable; many fine roots; patchy thin discontinuous

clay films; common medium sandstone fragments; abrupt smooth boundary.

Cr—29 to 36 inches; dark yellowish brown (10YR 4/4) soft weathered sandstone; thin lenses of clay loam shale.

Thickness of the solum and depth to weathered soft sandstone range from 20 to 40 inches. Fragments of weathered sandstone comprise less than 35 percent of the soil mass of any horizon.

The A1 horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It is loam or fine sandy loam. The A2 horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 3 or 4. The B horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5; and chroma of 4 through 8. It is loam or clay loam. It is 25 to 35 percent clay. In some pedons, subhorizons of the B horizon range to as much as 38 percent clay. Reaction ranges from medium acid to very strongly acid. The Cr horizon is soft, weathered rippable sandstone.

Bremer series

This series consists of deep, poorly drained, slowly permeable soils on second bottoms or terraces. These soils formed in silty alluvium of recent age. Slopes are 0 to 2 percent.

Bremer soils are mapped with Nodaway, Blackoar, Wabash, and Zook soils on flood plains. Nodaway soils are moderately well drained, are browner throughout, and are on natural levees along streams and former channels of streams. Blackoar soils are not so fine textured and are in low depressions. Wabash and Zook soils have a mollic epipedon that is more than 36 inches thick. These soils are in depressions.

Typical pedon in an area of Bremer silty clay loam, 1,420 feet east and 700 feet south of center of sec. 11, T. 46 N., R. 28 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam; weak very fine subangular blocky structure; friable; many coarse roots; medium acid; abrupt smooth boundary.

A12—6 to 10 inches; very dark gray (10YR 3/1) silty clay loam; weak very fine subangular blocky structure; friable; many coarse roots; very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; abrupt smooth boundary.

B21t—10 to 13 inches; very dark gray (N 3/) silty clay loam; weak fine subangular blocky structure; firm; many coarse roots; thin discontinuous clay films on the faces of some peds; slightly acid; abrupt smooth boundary.

B22tg—13 to 31 inches; very dark gray (N 3/) silty clay; few fine prominent dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; many fine roots; thin continuous clay films; few fine black concretions; slightly acid; gradual smooth boundary.

B31t—31 to 50 inches; dark gray (10YR 4/1) silty clay loam; many fine prominent olive gray (5Y 4/2) and few fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; firm; common fine roots; few fine black concretions; thick discontinuous clay films; slightly acid; gradual smooth boundary.

B32t—50 to 63 inches; dark gray (10YR 4/1) silty clay loam; common fine distinct (10YR 5/4) yellowish brown mottles; moderate medium subangular blocky structure; few fine roots; few fine black concretions; common medium clay films on faces of some peds; firm; slightly acid.

Thickness of the solum is more than 40 inches. There are no carbonates to a depth of more than 60 inches. The A horizon is 10 to 26 inches thick. It is black (10YR 2/1) and very dark gray (10YR 3/1) or very dark gray (N 3/0). It is 24 to 34 percent clay. Value of 3 and chroma of 1 or lower extend to a depth of 24 to 36 inches. The B2t horizon ranges from 16 to 28 inches in thickness. The upper part of the B horizon commonly has value of 3, but value increases to 4 or 5 as depth increases. Hue is 10YR, 2.5Y, or 5Y.

Deepwater series

This series consists of deep, moderately well drained, moderately permeable soils on narrow to moderately wide upland ridgetops and side slopes. These soils formed in residuum weathered from shale covered with a thin loess mantle. Slopes are 2 to 9 percent.

Deepwater soils are similar to Barco soils and commonly are adjacent to Barco, Haig, Mandeville, and Sampsel soils. Barco soils are well drained and are moderately deep. They formed in residuum from weathered sandstone. Haig soils are poorly drained, have a finer textured B2t horizon, and are nearly level. Mandeville soils do not have a mollic epipedon, are moderately deep, and typically are nearly level. Mandeville soils typically are below Deepwater soils. Sampsel soils are somewhat poorly drained, have a finer textured B2t horizon, and typically have seepage areas.

A typical pedon of Deepwater silt loam, 2 to 5 percent slopes, 1,020 feet north and 40 feet east of the center of sec. 2, T. 45 N., R. 28 W.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam; weak very fine granular structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

A12—7 to 10 inches; dark brown (10YR 3/3) silt loam; weak very fine subangular blocky structure; very friable; many fine roots; neutral; abrupt smooth boundary.

B1—10 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak very fine subangular blocky structure; friable; many fine roots; many worm casts; neutral; abrupt smooth boundary.

B21t—16 to 23 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak very fine subangular blocky structure; friable; many fine roots and root pores; medium acid; gradual smooth boundary.

B22t—23 to 36 inches; dark brown (10YR 4/3) silty clay loam; weak very fine subangular blocky structure; friable; many fine roots; thin discontinuous clay films; few fine shale fragments; strongly acid; abrupt smooth boundary.

B23t—36 to 53 inches; brown (10YR 5/3) silty clay loam; many fine prominent reddish brown (5YR 4/4) and yellowish brown (10YR 5/6) mottles; moderate very fine subangular blocky structure; friable; many fine roots; discontinuous clay films; many fine black concretions; few fine shale fragments; slightly acid; abrupt smooth boundary.

B3t—53 to 75 inches; yellowish brown (10YR 5/6) silty clay loam; many medium prominent gray (10YR 5/1), yellow (10YR 5/6), and black (10YR 2/1) mottles; moderate very fine subangular blocky structure; firm; few fine roots; thick discontinuous clay films; few fine shale fragments; neutral.

Thickness of the solum ranges from 48 to 60 inches or more. Thickness of the mollic epipedon ranges from 11 to 24 inches.

The A horizon has hue of 10YR, value of 3, and chroma of 1 through 3. The B2 horizon has hue of 10YR or 7.5YR, value of 3 through 6, and chroma of 2 through 6; it is darker in the upper part of the horizon. The B2 horizon is silty clay loam, and averages 32 to 35 percent clay in the upper 20 inches. A C horizon is in some pedons.

Dockery series

This series consists of deep, somewhat poorly drained, moderately permeable soils on bottom lands. These soils formed in silty alluvium. Slopes are 0 to 2 percent.

Dockery soils are similar to Blackoar soils and commonly are adjacent to Nodaway and Zook soils. Blackoar soils are more poorly drained and do not have the stratified subsoil characteristic of Dockery soils. Nodaway soils are moderately well drained and are on natural levees along the stream channel. Zook soils are poorly drained, are finer textured, and are darker throughout. Zook soils are near the uplands where slack water has deposited fine textured material.

Typical pedon in an area of Dockery silty clay loam, 1,270 feet west and 635 feet south of the northeast corner of sec. 34, T. 47 N., R. 25 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam; light brownish gray (10YR 6/2) silt strata; weak fine granular structure; very friable; many roots; slightly acid; clear smooth boundary.

C1—9 to 36 inches; stratified dark grayish brown (10YR 4/2) silty clay loam; light brownish gray (10YR 6/2) silt strata; massive tending to platy as a result of stratification; very friable; many roots; very dark gray (10YR 3/1) organic stains on faces of peds; slightly acid; clear smooth boundary.

C2—36 to 48 inches; stratified grayish brown (10YR 5/2) silt loam; massive; very friable; many fine light gray (10YR 7/1) silt coatings between strata; few dark gray (10YR 4/1) organic coatings; slightly acid; gradual smooth boundary.

C3—48 to 90 inches; grayish brown (10YR 5/2) silt loam; many coarse distinct gray (10YR 5/1) and common medium prominent dark brown (7.5YR 4/4) mottles; massive; very friable; common fine roots, few fine root pores; slightly acid; water table at a depth of 85 inches.

Reaction is slightly acid or neutral. The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 2. It is silty clay loam or silt loam. The C horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2. Mottles have hue of 2.5Y or 10YR, value of 4 through 6, and chroma of 2 through 8. Lenses of coarser or finer textured material less than 6 inches thick are common. The 10- to 40-inch control section is 20 to 30 percent clay.

Freeburg series

This series consists of deep, somewhat poorly drained, moderately slowly permeable silty soils on second bottom lands and terraces along the major streams. These soils formed in silty alluvium where trees are the main vegetation. Slopes are 0 to 2 percent.

Freeburg soils are similar to Lightning soils and commonly are adjacent to Lightning, Blackoar, Bremer, and Nodaway soils. Lightning soils are very slowly permeable and have a finer textured B horizon. Blackoar soils have a mollic epipedon, are poorly drained, and are along streams on bottom lands. Bremer soils are poorly drained, have a mollic epipedon, and have a finer textured B horizon. Nodaway soils have a mollic epipedon, are moderately well drained, and are on stream bottom lands below Freeburg soils.

Typical pedon in an area of Freeburg silt loam, 1,000 feet east and 25 feet north of the center of sec. 18, T. 47 N., R. 27 W.

Ap—0 to 5 inches; dark brown (10YR 4/3) silt loam; weak fine platy structure parting to weak fine granular; very friable; common roots; slightly acid; abrupt smooth boundary.

A12—5 to 7 inches; dark brown (10YR 4/3) silt loam; weak thin platy structure parting to weak fine granular; very friable; many roots; slightly acid; abrupt smooth boundary.

A2—7 to 13 inches; brown (10YR 5/3) silt loam; weak fine granular structure; very friable; common roots; slightly acid; abrupt smooth boundary.

B1—13 to 17 inches; brown (10YR 5/3) silt loam; weak fine granular structure; very friable; common roots; strongly acid; abrupt smooth boundary.

B21t—17 to 22 inches; mottled, dark grayish brown (10YR 4/2) and brown (10YR 5/3) silty clay loam; moderate fine subangular blocky structure; friable; common roots; pale brown (10YR 6/3) silt coatings; few fine black concretions; strongly acid; abrupt smooth boundary.

B22t—22 to 39 inches; brown (10YR 5/3) silty clay loam; common medium faint dark brown (10YR 4/2) and yellowish brown (10YR 5/4) mottles and common medium prominent dark reddish brown (5YR 3/3) mottles; weak fine subangular blocky structure; friable; common roots; pale brown (10YR 6/3) silt coatings; few fine black concretions; strongly acid; gradual smooth boundary.

B3t—39 to 51 inches; dark brown (10YR 4/3) silty clay loam; few fine faint dark yellowish brown (10YR 4/6) and grayish brown (10YR 5/2) mottles; weak coarse blocky structure; friable; few roots; pale brown (10YR 6/3) silt coatings; common fine black concretions; medium acid; gradual smooth boundary.

C—51 to 82 inches; dark brown (10YR 3/3) silty clay loam; few fine faint dark yellowish brown (10YR 4/4) and grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few roots; few fine black concretions; slightly acid.

Thickness of the solum ranges from 33 to 60 inches or more. The A horizon has hue of 10YR, value of 4 to 6, and chroma of 2 or 3. It is silt loam or loam and is slightly acid or neutral. The B horizon has hue of 10YR, value of 4 to 6, and chroma of 1 through 6. In this horizon, mottles have high chroma and chroma of 2 or less. Reaction ranges from medium acid to strongly acid in the upper part of the B horizon to strongly acid or very strongly acid in the lower part.

Gorin series

This series consists of deep, somewhat poorly drained, slowly permeable soils on loess covered uplands. Slopes are 5 to 9 percent.

Gorin soils are similar to Weller soils and are commonly adjacent to Weller, Deepwater, and Sampsel soils. Weller soils have less clay in the lower part of the solum and typically are on the less sloping ridgetops above Gorin soils. Deepwater soils are moderately well drained, have a mollic epipedon, and are in higher positions on the landscape. Sampsel soils formed in residuum weathered from shale, have a mollic epipedon, and are on side slopes above Gorin soils.

Typical pedon in an area of Gorin silt loam, 5 to 9 percent slopes, eroded, 1,100 feet east and 20 feet south of the center of sec. 28, T. 48 N., R. 24 W.

Ap—0 to 5 inches; dark brown (10YR 4/3) silt loam; weak very fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

B21t—5 to 15 inches; brown (10YR 5/3) silty clay; few fine distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; firm; many fine roots; thin discontinuous clay films; slightly acid; clear smooth boundary.

B22t—15 to 26 inches; mottled light grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) silty clay loam; moderate medium subangular blocky structure; firm; many fine roots; thin discontinuous clay films; slightly acid; abrupt smooth boundary.

IIB31t—26 to 35 inches; brown (10YR 5/3) silty clay loam; many fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few fine roots between peds; thin discontinuous clay films; many medium black concretions; thick, wide black oxide stains; neutral; clear smooth boundary.

IIB32t—35 to 60 inches; brown (10YR 5/3) silty clay loam; many medium prominent yellowish brown (10YR 5/8) mottles and many fine distinct light gray (10YR 7/1) mottles; moderate medium blocky structure parting to prismatic; many fine roots along structure faces; common medium black concretions; neutral.

The thickness of the solum ranges from 48 to 60 inches or more. The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 3 or 4. Some pedons have an A1 horizon. It is silt loam less than 3 inches thick and has chroma of 1 or 2. The A2 horizon, if present, has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The B horizon has hue of 10YR, value of 4 through 6, and chroma of 1 through 4. It is silty clay loam or silty clay. Mottles of higher and lower value or chroma are common throughout this horizon. Reaction ranges from neutral to strongly acid.

Haig series

This series consists of deep, poorly drained, slowly permeable, or very slowly permeable soils on broad ridgetops. These soils formed in loess or water-worked material. Slopes are 0 to 2 percent.

Haig soils are similar to Macksburg soils and are commonly adjacent to Deepwater and Sampsel soils. Macks-

burg soils are somewhat poorly drained. Deepwater soils are moderately well drained, have less clay in the B2t horizon, and commonly are on the narrower, more sloping ridge points. Sampsel soils are not so deep and are steeper.

Typical pedon in an area of Haig silt loam, 1,220 feet east and 1,800 feet north, of the southwest corner of sec. 12, T. 45 N., R. 28 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam; weak fine granular structure; very friable; many roots; slightly sticky when wet; slightly acid; abrupt smooth boundary.

A3—7 to 10 inches; black (10YR 2/1) silty clay loam; moderate very fine subangular blocky structure; friable; many roots; few clean white sand and silt grains on faces of peds; slightly acid; abrupt smooth boundary.

B21t—10 to 13 inches; black (10YR 2/1) silty clay loam; moderate fine subangular blocky structure; firm; many roots; streaks of gray (10YR 5/1) throughout horizon; medium acid; abrupt smooth boundary.

B22t—13 to 30 inches; black (10YR 2/1) silty clay; few fine clear dark gray (10YR 4/1) mottles and prominent dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; very firm; many fine roots; few fine brown concretions; medium acid; clear smooth boundary.

B23t—30 to 38 inches; grayish brown (2.5Y 5/2) silty clay; few fine prominent yellowish brown mottles (10YR 5/6); weak fine subangular blocky structure; firm; few fine roots; few vertical cracks filled with black (10YR 2/1) material from horizons above; common fine brown and black concretions (2 to 5 millimeters); thick discontinuous clay films; medium acid; gradual smooth boundary.

B3—38 to 64 inches; gray (2.5Y 5/2) silty clay loam; few fine to coarse light gray (10YR 7/1) and yellowish brown (10YR 5/6) mottles; weak coarse blocky structure; firm; few fine roots and root pores; thick black (10YR 2/1) discontinuous clay films along former cracks and in root pores; slightly acid.

Thickness of the solum ranges from 48 to 60 inches or more. Thickness of the mollic epipedon ranges from 20 to 34 inches.

The A horizon has hue of 10YR, value of 2 or 3, chroma of 1 or 2. It is dominantly silt loam but ranges to light silty clay loam. The B2 horizon has hue of 10YR, value of 2 through 4, and chroma of 1. The upper part of the horizon is darker. This horizon is dominantly silty clay but ranges to silty clay loam and averages 40 to 50 percent clay. The B3 horizon has hue of 10YR, value of 4 or 5, and chroma of 0 or 1. It is light silty clay or silty clay loam. Reaction is slightly acid or medium acid.

Hartwell series

This series consists of deep, somewhat poorly drained, slowly permeable soils on loess covered uplands. These soils contain a component of residuum from shale in the lower part of the B horizon and in the C horizon. Slopes are 0 to 5 percent.

Hartwell soils are similar to Haig soils and are commonly adjacent to Deepwater and Sampsel soils. Haig soils have a thicker and darker mollic epipedon. Deepwater soils are moderately well drained and are on the narrower, more sloping ridge points. Sampsel soils have a black mollic epipedon that continues into the upper part of the argillic horizon. Those soils are steeper than Hartwell soils.

Typical pedon in an area of Hartwell silt loam, 0 to 2 percent slopes, 1,200 feet east and 1,100 feet north of center of sec. 23, T. 44 N., R. 24 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many roots; few very fine black concretions; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches; mixed grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) silt loam; few fine prominent light gray (10YR 7/2) mottles; weak very fine granular structure; very friable; many roots; few fine black concretions; slightly acid; clear smooth boundary.

B22t—12 to 21 inches; very dark grayish brown (10YR 3/2) silty clay; very dark gray (10YR 3/1) ped faces; common fine prominent dark yellowish brown (10YR 4/4) mottles; weak very fine subangular blocky structure; very firm; many roots; thick continuous clay films; common fine black concretions; medium acid; clear smooth boundary.

B23t—21 to 33 inches; dark grayish brown (10YR 4/2) silty clay; few fine prominent dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; very firm; common roots; thin discontinuous clay films; common fine black concretions; slightly acid; clear smooth boundary.

B3t—33 to 54 inches; light brownish gray (10YR 6/2) silty clay loam; many fine prominent dark yellowish brown (10YR 4/4) and black (10YR 2/1) mottles and few fine faint light gray (10YR 7/1) mottles; moderate medium prismatic structure parting to weak medium subangular blocky; firm; common fine roots; thin discontinuous clay films; many clean sand grains; neutral; gradual smooth boundary.

C—54 to 78 inches; grayish brown (10YR 5/2) silty clay loam; many coarse prominent yellowish brown mottles and many coarse distinct light gray (10YR 7/1) mottles; massive; firm; few fine roots; common black concretions; neutral.

Thickness of the solum ranges from 30 to 56 inches. The A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has value of 5 or 6 and chroma of 1 or 2. The B2 horizon has value of 2 or 3 and chroma of 1 through 3. It is silty clay or clay. Reaction is strongly acid to slightly acid. The B3 horizon has value of 5 through 7 and chroma of 2 through 8. It is commonly silty clay loam but ranges to silt loam and silty clay. Reaction is strongly acid to neutral.

Hartwell silt loam, 2 to 5 percent slopes, eroded, does not have an A2 horizon; therefore, this unit is outside the range for the series. This difference, however, does not seriously alter the use and management of this soil.

Higginsville series

This series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in deep loess. Slopes are 4 to 7 percent.

Higginsville soils are similar to Macksburg soils and commonly are adjacent to Macksburg, Haig, and Sampsel soils. Macksburg soils are moderately slowly permeable. They are on ridgetops above Higginsville soils. Sampsel soils are in drainageways below Higginsville soils, and they have a silty clay loam surface layer. Haig soils are on broad, flat ridgetops and are poorly drained.

Typical pedon in an area of Higginsville silt loam, 4 to 7 percent slopes, 1,100 feet west and 260 feet south of the northeast corner of sec. 32, T. 48 N., R. 26 W.

Apl—0 to 5 inches; black (10YR 2/1) silt loam; weak fine granular structure; very friable; abundant fine roots; few fine black concretions; neutral; abrupt smooth boundary.

Ap2—5 to 8 inches; black (10YR 2/1) silt loam; moderate medium subangular blocky structure; very friable; abundant fine roots; few fine black concretions; neutral; abrupt smooth boundary.

Blt—8 to 11 inches; black (10YR 2/1) silty clay loam; weak fine subangular blocky structure; friable; abundant fine roots; few fine black concretions; slightly acid; abrupt smooth boundary.

B22t—11 to 17 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct dark brown (10YR 4/3) mottles; weak fine subangular blocky structure; firm; abundant fine roots; few fine black concretions; slightly acid; abrupt smooth boundary.

B23t—17 to 29 inches; dark grayish brown (10YR 4/2) silty clay loam; many medium prominent gray (10YR 6/1) mottles and many medium distinct very dark gray (10YR 3/1), light yellowish brown (10YR 6/4), and yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; abundant fine roots; few medium black concretions; slightly acid; abrupt smooth boundary.

B31t—29 to 50 inches; gray (10YR 6/1) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; coarse prismatic structure parting, in places, to weak coarse blocky; few thick discontinuous clay films; firm; few fine roots; slightly acid; gradual smooth boundary.

B32t—50 to 69 inches; gray (10YR 6/1) silty clay loam; few fine prominent dark yellowish brown (10YR 4/4) mottles; coarse prismatic structure parting, in places, to weak coarse blocky; firm; few very fine roots; slightly acid.

Thickness of the solum typically is about 50 inches, and it ranges from 38 to 69 inches or more. Thickness of the mollic epipedon averages about 20 inches but ranges from 10 to 24 inches or more. The A horizon is medium acid to neutral. The B horizon is slightly acid to strongly acid.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam or light silty clay loam. The B1 and B2 horizons have dominant hue of 10YR, value of 3 or 4, and chroma of 2 or 3. In some pedons, there are coatings on faces of peds that have chroma of 1. Mottles of higher value and chroma are common. The B3 horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. Mottles have hue of 5YR through 10YR, value of 3 through 5, and chroma of 3 through 8.

Kanima series

This series consists of deep, well drained, moderately rapidly permeable soils on very steep uplands. These soils formed in material weathered from shale, sandstone, and limestone that remained after strip mining. Slopes are 30 to 60 percent.

Kanima soils commonly are adjacent to Deepwater and Hartwell soils. Deepwater soils are moderately well drained, have a mollic epipedon, and are less sloping. Hartwell soils are somewhat poorly drained, have a mollic epipedon, and are nearly level on ridgetops and at the heads of drainageways. These soils are relatively undisturbed and surround the radically altered Kanima soils.

Typical pedon in an area of Kanima shaly silty clay loam, 30 to 60 percent slopes, in an abandoned strip mine spoilbank, 2,500 feet west and 400 feet south of northeast corner of sec. 26, T. 44 N., R. 25 W.

A1—0 to 7 inches; 90 percent light gray (10YR 7/2) and 10 percent dark grayish brown (10YR 4/4) shaly silty clay loam; strong thin platy structure; weak very fine granular structure; friable; 80 percent gray (10YR 6/1) and red (2.5YR 5/6) shale fragments; extremely acid; abrupt wavy boundary.

C1—7 to 19 inches; light brownish gray (10YR 6/2) shaly silty clay loam; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; friable; 80 percent light gray (10YR 7/1) and reddish brown (10YR 5/6) shale fragments; 2 percent chan-

nery limestone rock; extremely acid; abrupt wavy boundary.

C2—19 to 28 inches; gray (10YR 6/1) shaly silty clay loam; weak very thin platy structure; friable; 80 percent light brownish gray (10YR 6/2) and brownish yellow (10YR 6/6) shale fragments; few small pockets dark yellowish brown (10YR 4/6) silty clay loam soil material; extremely acid; abrupt irregular boundary.

C3—28 to 60 inches; gray (10YR 5/1) shaly silty clay loam; moderate coarse subangular blocky structure parting to moderate fine subangular blocky structure; friable; 80 percent yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/6) shale fragments; 1 percent coal fragments; extremely acid.

This soil is extremely acid to strongly acid. Coal fragments range from a trace to 5 percent. The A horizon has dominant hue of 10YR (some pedons have hue of 2.5Y or 5Y), value of 5 through 7, and chroma of 1 through 4. In some pedons, the A horizon has pockets of material with value of 3. Rock fragments less than 3 inches in diameter range from 0 to 10 percent. The C horizon commonly has hue of 10YR or 5Y, value of 4 through 6, and chroma of 1 through 6. Some fragments or pockets of soil material have value of 3 or lower. In the C horizon, rock fragments less than 3 inches in diameter range from 25 to 85 percent, and fragments more than 3 inches in diameter range from 2 to 30 percent. Rock fragments are in shades of gray, brown, yellow, and red.

Lightning series

This series consists of deep, somewhat poorly drained, very slowly permeable soils on flood plains and low terraces. These soils formed in silty alluvium of recent deposition. Slopes are 0 to 2 percent.

Lightning soils are similar to Freeburg soils and commonly are adjacent to Freeburg, Bremer, Nodaway, and Zook soils. Freeburg soils have a coarser textured subsoil and typically are higher on the stream terraces. Bremer soils have a mollic epipedon and are on the larger terraces farther back from the stream channel. Nodaway soils are moderately well drained, are browner throughout, and are along streams and former stream channels. Zook soils are poorly drained, have a thick mollic epipedon, are finer textured throughout, and are on large flood plains below Lightning soils.

Typical pedon in an area of Lightning silt loam, 2,200 feet north and 30 feet west of the southeast corner of sec. 22, T. 45 N., R. 27 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) silt loam; weak very fine granular structure; very friable; few fine roots; very strongly acid; abrupt smooth boundary.

A2—8 to 14 inches; light brownish gray (2.5YR 6/2) silty clay loam; few fine distinct light gray (10YR 7/2) and yellowish brown (10YR 5/6) mottles; weak very fine subangular blocky structure; very friable; common fine roots; very strongly acid; clear smooth boundary.

B1g—14 to 18 inches; light brownish gray (2.5Y 6/2) and mixed dark grayish brown (10YR 4/2) silty clay loam; few fine distinct light gray (10YR 7/2) and yellowish brown (10YR 5/6) mottles; weak very fine subangular blocky structure; friable; common fine roots; common white silt coatings; few grayish brown worm casts; very strongly acid; clear smooth boundary.

B21tg—18 to 22 inches; light brownish gray (10YR 6/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) and common medium distinct light gray (10YR 7/2) mottles; weak fine subangular blocky structure; firm; thin patchy clay films along old root channels; common fine roots; few white silt coatings; few grayish brown worm casts; very strongly acid; gradual smooth boundary.

B22t—22 to 30 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct white (10YR 8/1), common medium distinct light gray (10YR 7/2), and common fine distinct yellowish red (5YR 4/6) mottles; weak fine prismatic structure parting to weak very fine subangular blocky; firm; thin patchy clay films; few fine roots; few fine black concretions; few grayish brown worm casts; very strongly acid; gradual smooth boundary.

B23tg—30 to 46 inches; dark grayish brown (10YR 4/2) silty clay loam; common medium distinct light gray (10YR 7/2), common fine distinct white (10YR 8/1), and few fine distinct reddish brown (5YR 4/3) mottles; weak fine prismatic structure parting to weak very fine subangular blocky; firm; thin patchy clay films; few fine roots; few fine black concretions; strongly acid; gradual smooth boundary.

B3tg—46 to 59 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles and common fine distinct light gray (10YR 7/2) and strong brown (7.5YR 5/6) mottles; weak very fine subangular blocky structure; firm; thin patchy clay films along old root channels; few fine black concretions; very strongly acid; gradual smooth boundary.

Cg—59 to 78 inches; gray (10YR 5/1) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles and few fine distinct reddish brown (5YR 4/3) mottles; very dark gray (10YR 3/1) on some ped faces; massive; few fine black concretions; strongly acid.

Thickness of the solum ranges from 40 to 60 inches or more. The average clay content of the control section ranges from 35 to 45 percent.

The Ap or A1 horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is dominantly silt loam but ranges to silty clay loam. Most pedons have an A2 horizon that has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 or 2. The A horizon ranges from slightly acid to very strongly acid.

The B1 horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 or 2. It is mottled with gray, red, or brown. The B2 horizon has hue of 10YR, value of 3 through 6, and chroma of 1 or 2. It is mottled with gray, red, or brown. It is silty clay loam or silty clay. The B3 horizon and C horizon are similar in color and texture to the B2 horizon. The B horizon ranges from neutral to very strongly acid throughout.

Macksburg series

This series consists of deep, somewhat poorly drained, moderately slowly permeable soils on broad ridgetops. These soils formed in silty loess. Slopes are 1 to 4 percent.

Macksburg soils are similar to Haig soils and commonly are adjacent to Haig, Sampsel, and Polo soils. Haig soils are more poorly drained than Macksburg soils. Sampsel soils are slowly permeable, and they are steeper. They formed in residuum weathered from limestone and shale. Polo soils are well drained and have redder hue in the B and C horizons.

Typical pedon in an area of Macksburg silt loam, 1 to 4 percent slopes, 660 feet north and 200 feet east of center of sec. 29, T. 48 N., R. 26 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine granular structure; very friable; many roots; slightly acid; abrupt smooth boundary.

A12—8 to 10 inches; black (10YR 2/1) silty clay loam; weak fine granular structure; very friable; few very fine black concretions; slightly acid; abrupt smooth boundary.

A3—10 to 20 inches; very dark brown (10YR 2/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak very fine subangular blocky structure; friable; fine black concretions; few very dark grayish brown wormcasts; slightly acid; clear smooth boundary.

B22t—20 to 38 inches; dark grayish brown (10YR 4/2) silty clay loam; common dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; strong fine and medium subangular blocky structure; firm; thick discontinuous black and dark grayish brown clay films; fine black concretions; medium acid; gradual smooth boundary.

B3t—38 to 58 inches; yellowish brown (10YR 5/4) silty clay loam; common coarse prominent light olive gray (5Y 6/2) and few fine black (10YR 2/1) mottles; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; friable; medium and thin discontinuous clay films on some ped faces; large black concretions and soft deposits of an oxide; slightly acid; gradual smooth boundary.

C—58 to 94 inches; grayish brown (2.5Y 5/2) silty clay loam; many coarse prominent dark yellowish brown (10YR 4/4) mottles; massive; some vertical cleavage; friable; few fine root pores and other rounded pores; thick discontinuous clay films on faces of pores; slightly acid.

Solum thickness typically is about 60 inches and ranges from 48 to 84 inches. The soil typically is slightly acid to strongly acid in the A horizon and B horizon and slightly acid or neutral at a depth of about 6 feet. The A horizon ranges from 16 to 24 inches in thickness. The mollic epipedon ranges from about 16 to 28 inches in thickness. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam or silty clay loam. The B2 horizon has hue of 10YR, value of 4, and chroma of 2 through 4. Mottles of higher value and chroma are common throughout the B2 horizon. The B3 horizon and C horizon have mottles that have hue of 10YR, 2.5Y, and 5Y; value of 4 through 6; and chroma of 2 through 4.

Mandeville series

This series consists of moderately deep, moderately well drained, moderately permeable soils on uplands. These soils formed in silty residuum from sandstone, siltstone, and shale. The native vegetation consisted mainly of oak, hickory, and ash. Slopes are 2 to 9 percent.

Mandeville soils commonly are adjacent to Deepwater, Norris, Sampsel, and Snead soils. Deepwater, Sampsel, and Snead soils are darker and Deepwater and Sampsel soils are thicker than Mandeville soils. Sampsel and Snead soils are finer textured throughout. Norris soils are not so deep and are steeper than Mandeville soils.

Typical pedon in an area of Mandeville silt loam, 5 to 9 percent slopes, 1,310 feet north and 30 feet west of the center of sec. 17, T. 45 N., R. 24 W.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; very dark brown (10YR 2/2) partly decomposed forest litter; very friable; many fine roots; strongly acid; abrupt smooth boundary.

A2—3 to 6 inches; mixed yellowish brown (10YR 5/4) and brown (10YR 4/3) crushed silt loam; weak fine granular structure; very friable; some yellowish brown (10YR 6/3) spots (not mottles); many fine roots; strongly acid; abrupt smooth boundary.

B1—6 to 8 inches; strong brown (7.5YR 5/6) silty clay loam; weak fine subangular blocky structure; friable;

many fine roots; strongly acid; clear smooth boundary.

B2t—8 to 17 inches; strong brown (7.5YR 5/6) silty clay loam; weak fine subangular blocky structure; friable; many fine roots; thin discontinuous clay films; 10 percent shale fragments (2 to 5 millimeters); strongly acid; abrupt smooth boundary.

B3t—17 to 29 inches; mottled, strong brown (7.5YR 5/6) and light brownish gray (10YR 5/6) silty clay loam; weak medium subangular blocky structure; friable; many fine roots; thick dark brown (10YR 3/3) patchy clay films; large to fine root pores; 10 percent shale fragments (2 to 5 millimeters); fine mica flakes visible; strongly acid; gradual smooth boundary.

Cr—29 to 60 inches; light brownish gray (10YR 6/2), yellowish brown (10YR 5/6), and very dark gray (10YR 3/1) micaceous shale.

The solum and depth to soft shale bedrock ranges from 20 to 40 inches. The A1 horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The A2 horizon has hue of 10YR, value of 5 or 6, and chroma of 3 or 4. The B horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 3 through 6. It contains 10 to 25 percent weathered shale that ranges from very strongly acid to medium acid and is at least strongly acid in some part. The C horizon is weathered, soft, rippable, micaceous shale. In some pedons, the upper part of this horizon is loam or silt loam that has rocklike structure and contains many shale fragments. In some pedons, the shale has thin strata of hard limestone.

Nodaway series

This series consists of deep, moderately well drained, moderately permeable soils on bottom lands. These soils formed in loamy alluvium in areas where mixed hardwoods were probably the native vegetation. Slopes are 1 to 5 percent.

Nodaway soils are similar to Blackoar soils and commonly are adjacent to Blackoar, Freeburg, and Zook soils. Blackoar soils are poorly drained. Freeburg soils are somewhat poorly drained and are on terraces or second bottoms above Nodaway soils. Zook soils are poorly drained, have a higher clay content throughout the profile, and border the Nodaway soils near the natural stream levee.

Typical pedon in an area of Nodaway silt loam, 2,540 feet south and 1,400 feet west of the northeast corner of sec. 7, T. 46 N., R. 27 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam; weak very fine granular structure; very friable; many roots; neutral; abrupt smooth boundary.

C—9 to 60 inches; dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) silt loam; massive with horizontal cleavage planes; many fine roots; neutral.

The depth to bedrock is more than 40 inches. The mollic epipedon typically is 7 to 12 inches thick and extends into the C horizon in some pedons.

The A horizon has hue of 10YR, value of 3, and chroma of 1 or 2. It is predominantly silt loam but ranges to silty clay loam. The C horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. Some strata have hue of 10YR, value of 4 or 5, and chroma of 2 through 4. The C horizon is silt loam or silty clay loam. Reaction ranges from slightly acid to neutral throughout the profile.

Norris series

This series consists of shallow, well drained, moderately permeable soils on uplands. These soils formed in residuum weathered from soft shale. Slopes are 5 to 35 percent.

Norris soils are similar to Mandeville soils and commonly are adjacent to Mandeville, Bolivar, and Snead soils. Mandeville and Bolivar soils are thicker and have an argillic horizon. Mandeville soils typically are in higher positions on the slopes. Bolivar soils are in areas where the underlying material changes from shale to sandstone. Snead soils are thicker, have a cambric horizon, and are in areas where limestone is at or near the surface.

Typical pedon in an area of Norris shaly silt loam, 5 to 14 percent slopes, 1,880 feet west and 2,300 feet north of the southeast corner of sec. 29, T. 46 N., R. 24 W.

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) shaly silt loam; weak fine granular structure; very friable; many roots; 15 percent fine shale fragments; very strongly acid; clear wavy boundary.

B1—2 to 7 inches; yellowish brown (10YR 5/4) shaly silt loam; weak fine subangular blocky structure; very friable; many roots; 30 percent coarse shale fragments (1 centimeter to 6 centimeters); few fine black concretions (Fe and Mn oxides); very strongly acid; abrupt wavy boundary.

B2—7 to 16 inches; light olive brown (2.5Y 5/4) shaly silt loam; few fine faint brown (7.5YR 5/4) mottles; moderate fine subangular blocky structure; firm; common thick roots; 30 percent fine shale fragments (1 millimeter to 10 millimeters); few fine black concretions (Fe and Mn oxides); very strongly acid; abrupt wavy boundary.

Cr1—16 to 24 inches; yellowish brown (10YR 5/4) shaly silty clay loam; weak very fine subangular blocky structure; very friable; few roots; light olive yellow (5Y 6/2) and strong brown (7.5YR 5/8) thinbedded sandy shale; extremely acid; abrupt wavy boundary.

Cr2—24 to 60 inches; olive gray (5Y 5/2) and gray (N 5/0), thinbedded soft micaceous shale that has

brown and red weathered edges; easily dug with hand spade; few fine roots; extremely acid.

Thickness of the solum and depth to soft shale bedrock range from 8 to 20 inches. Coarse shale fragments range from 10 to 35 percent, by volume, throughout the profile. The solum is strongly acid or very strongly acid.

The A horizon has hue of 10YR, value of 3, and chroma of 1 or 2. If disturbed, the A horizon has value of 4. It is loam or silt loam. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 4. It is predominantly silt loam, but in some pedons the lower part is light silty clay loam or clay loam. It is more than 15 percent coarser than very fine sand, including fragments as much as 3 inches in diameter. The C horizon is light silty clay loam intermixed with soft micaceous shale in the upper part and thinbedded soft micaceous acid shale in the lower part. It has value of 3 through 6 and chroma of 2 through 5. It is very strongly acid or extremely acid.

Polo series

This series consists of deep, well drained, moderately permeable soils on loess covered uplands. These soils formed in mixed loess and residuum from limestone and shale. Slopes are 2 to 9 percent.

Polo soils are similar to Macksburg soils and commonly are adjacent to Macksburg, Sampsel, and Snead soils. Macksburg soils are somewhat poorly drained and are on the broader, nearly level ridgetops. Sampsel soils are somewhat poorly drained and are on side slopes and ridge points. Snead soils are moderately deep and moderately well drained. They typically are below Polo soils where the slope is steeper and limestone and shale are on or near the surface.

Typical pedon in an area of Polo silt loam, 2 to 5 percent slopes, 100 feet west and 1,295 feet south of the northeast corner of sec. 17, T. 47 N., R. 27 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine granular structure; very friable; many roots; slightly acid; abrupt smooth boundary.

A12—6 to 9 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine granular structure; very friable; many roots; few dark yellowish brown worm casts; slightly acid; abrupt smooth boundary.

B1—9 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam; friable; many roots; few dark yellowish brown worm casts; medium acid; abrupt smooth boundary.

B21t—12 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine subangular blocky structure; firm; many roots; few dark yellowish brown worm casts; few fine clay films; medium acid; abrupt smooth boundary.

B22t—16 to 27 inches; dark brown (10YR 3/3) silty clay loam; moderate fine subangular blocky structure; firm; many roots; few dark yellowish brown worm casts; fine discontinuous clay films; medium acid; gradual smooth boundary.

B23t—27 to 50 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable; many fine roots; brown (7.5YR 5/4) ped faces; thick discontinuous clay films along vertical cracks and former cracks; strongly acid; gradual smooth boundary.

IIB3t—50 to 75 inches; reddish brown (5YR 4/4) silty clay loam; weak coarse blocky structure; friable; thick clay films along former root channels and vertical ped faces; some gray stains along cracks and former cracks; very strongly acid.

Thickness of the solum ranges from 48 to 95 inches. Thickness of the mollic epipedon ranges from 20 to 30 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 2 or 3. It is silt loam or silty clay loam. The B horizon has hue of 10YR or 7.5YR, value of 3 in the upper part and 4 in the lower part, and chroma of 3 or 4. In some pedons, the lower part of the B3 horizon has value and chroma of 5 or 6. In some pedons, a few faint mottles are below a depth of 2 feet. The IIB horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 4 through 8. It is silty clay loam or light silty clay. The B horizon ranges from medium acid to very strongly acid.

Sampsel series

This series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in residuum weathered from alkaline or calcareous shale. Slopes are 2 to 9 percent.

Sampsel soils are similar to Macksburg soils and are commonly adjacent to Macksburg, Deepwater, and Snead soils. Macksburg soils formed in loess and do not have shale fragments in the subsoil. Macksburg soils are on the larger and broader ridgetops. Deepwater soils are moderately well drained, contain less clay throughout the profile, and are on similar positions as those of Sampsel soils. Snead soils do not have an argillic horizon, have a thinner solum, and are in areas above or below Sampsel soils where limestone and shale bedrock is nearer the surface. Snead soils typically are steeper.

Typical pedon, in an area of Sampsel silty clay loam, 5 to 9 percent slopes, severely eroded, in a cornfield, 660 feet west and 1,760 feet north of the southeast corner of sec. 32, R. 28 W., T. 47 N.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam; weak fine subangular blocky structure parting to weak very fine granular; friable; many roots; medium acid; abrupt smooth boundary.

B21t—7 to 18 inches; black (10YR 2/1) silty clay loam; common medium distinct dark brown (10YR 4/3) mottles; moderate medium subangular blocky structure; firm; many roots; common medium black concretions (5 millimeters); slightly acid; abrupt smooth boundary.

B22t—18 to 36 inches; gray (10YR 5/1) silty clay; many fine distinct dark yellowish brown (10YR 4/4) and light gray (10YR 6/1) mottles; weak fine subangular blocky structure; very firm; thick discontinuous clay films; many fine roots; mild effervescence; few white concretions (15 centimeters); neutral; gradual smooth boundary.

B3—36 to 56 inches; brown (10YR 5/3) silty clay; many medium distinct gray (10YR 6/1) and yellowish brown (10YR 5/6) mottles; black (10YR 2/1) stains on ped faces; weak fine subangular blocky structure; very firm; thin discontinuous clay films; few fine roots; mild effervescence; few white concretions (15 centimeters); neutral; gradual smooth boundary.

C—56 to 91 inches; mottled gray (10YR 6/1) and strong brown (7.5YR 5.6) silty clay; many common prominent yellowish red (5YR 4/6) mottles; massive; very firm; few fine roots; mild effervescence; few white concretions (15 centimeters); mildly alkaline; gradual smooth boundary.

Thickness of the solum and the depth to free carbonates ranges from 36 to 70 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon and B1 horizon have hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A horizon is most commonly silty clay loam but ranges to silt loam. The B2t horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 1 or 2. Mottles are of higher chroma. The B2t horizon is silty clay loam or silty clay and is 36 to 48 percent clay. Reaction ranges from mildly alkaline to medium acid. The C horizon is neutral to moderately alkaline and contains free carbonates.

Sharpsburg series

This series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in loess. Slopes are 2 to 5 percent.

Sharpsburg soils are similar to Polo soils and commonly are adjacent to Polo, Macksburg, and Winfield soils. Polo soils are well drained, have redder hues in the subsoil, and typically are on the narrower, more sloping ridgetops. Macksburg soils are somewhat poorly drained, have darker hues throughout the profile, and are in the larger, nearly level areas of broad ridgetops. Winfield soils have a fine textured subsoil, do not have a mollic epipedon, and are on the narrow ridge points and side slopes below Sharpsburg soils.

Typical pedon in an area of Sharpsburg silt loam, 2 to 5 percent slopes, in a cornfield 840 feet east and 100 feet north of the center of sec. 25, T. 48 N., R. 26 W.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam; weak very fine granular structure; very friable; medium acid; abrupt smooth boundary.

A12—5 to 10 inches; very dark brown (10YR 2/2) silt loam; weak fine subangular blocky structure; friable; few roots; strongly acid; abrupt smooth boundary.

A3—10 to 17 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine granular structure; friable; many roots; medium acid; abrupt smooth boundary.

B21—17 to 29 inches; dark brown (10YR 3/3) and brown (10YR 4/3) crushed silty clay loam; weak fine subangular blocky structure; firm; many roots; few black concretions; thin discontinuous clay films; medium acid; clear smooth boundary.

B22—29 to 42 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine distinct light brownish gray (10YR 6/2) mottles; moderate fine subangular blocky structure; firm; many roots; few black concretions (Fe-Mg); thin discontinuous clay films; medium acid; gradual smooth boundary.

B3—42 to 53 inches; grayish brown (10YR 5/2) silty clay loam; few fine faint brown (10YR 4/3) and strong brown (7.5YR 5/6) mottles; weak fine prismatic structure parting to weak fine subangular blocky; firm; few coarse roots; few black concretions thin discontinuous clay films; medium acid; gradual smooth boundary.

C—53 to 85 inches; yellowish brown (10YR 5/4) silty clay loam; common medium prominent grayish brown (10YR 5/2) and few fine prominent light brownish gray (10YR 6/2) mottles; massive; few black concretions; medium acid.

Thickness of the solum ranges from 42 to 70 inches. There are no free carbonates to a depth of 60 inches or more. The mollic epipedon ranges from 10 to 30 inches.

The A horizon has hue of 10YR, value of 3, and chroma of 2 or 3. It is dominantly silt loam but is silty clay loam in a few places. The B horizon has hue of 10YR, value of 3 through 5, and chroma of 3 or 4. The B2t horizon has mottles that have hue of 7.5YR or 10YR, value of 4 through 6, and chroma of 2 through 6. The B horizon ranges from medium acid to strongly acid throughout. The average clay content of the control section ranges from 36 to 42 percent. The C horizon is mottled in hues of 10YR through 2.5Y, value of 4 through 6, and chroma of 2 through 4.

Snead series

This series consists of moderately deep, moderately well drained, slowly permeable soils. These soils formed

in residuum weathered from calcareous shale and thin interbedded limestone. Slopes are 5 to 35 percent.

Snead soils are similar to Sampsel soils and commonly are adjacent to Polo and Sampsel soils. Polo soils are thicker, are better drained, and commonly are above Snead soils where limestone bedrock is at a depth of more than 40 inches. Sampsel soils have a thicker mollic epipedon, are somewhat poorly drained, and are more than 40 inches deep to shale or limestone bedrock. Sampsel soils commonly surround Snead soils on side slopes.

Typical pedon of Snead silty clay loam in an area of Snead-Rock outcrop complex, 5 to 14 percent slopes, 50 feet north and 2,220 feet east of southwest corner of sec. 11, T. 46 N., R. 28 W.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine subangular blocky structure parting to weak very fine granular; very friable; many roots; few hard shale chips (5 percent); slightly acid; abrupt smooth boundary.

B21—5 to 10 inches; very dark grayish brown (10YR 3/2) silty clay; moderate fine subangular blocky structure; friable; many roots; few hard shale chips (5 percent); slightly acid; abrupt smooth boundary.

B22—10 to 20 inches; very dark grayish brown (10YR 3/2) silty clay; few coarse prominent light olive brown (2.5Y 5/4) mottles; moderate fine subangular blocky structure; very firm; few fine roots; black (10YR 2/1) organic stains on faces of peds; slightly acid; abrupt smooth boundary.

B3—20 to 24 inches; olive gray (5Y 5/2) silty clay; many fine prominent yellowish brown (10YR 5/4) and black (N 2/0) mottles; moderate medium subangular blocky structure; very firm; few fine roots; neutral; abrupt smooth boundary.

Cr1—24 to 35 inches; mottled olive gray (5Y 5/2) and yellowish brown (10YR 5/6) shaly silty clay loam; weak medium blocky structure; very firm; few medium roots; neutral; gradual smooth boundary.

Cr2—35 to 40 inches; olive gray (5Y 5/2) soft shale; few fine roots along cracks in the shale.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It is predominantly silty clay loam but ranges to silt loam. The B horizon is mottled with hue of 10YR, 2.5Y, or 5Y; value of 4 or 5; and chroma of 2 through 6. Typically, very dark gray (10YR 3/1) and black (10YR 2/1) stains or streaks are in the upper part of this horizon. It is silty clay or clay.

Wabash series

This series consists of deep, very poorly drained, very slowly permeable soils in large depressions on bottom lands. These soils formed in clayey alluvial material. Slopes are 0 to 1 percent.

Wabash soils are similar to Zook soils and commonly are adjacent to Blackoar, Dockery, and Zook soils. Blackoar and Dockery soils are better drained and coarser textured than Wabash soils. These soils typically are in positions along the main and tributary stream channels. Zook soils do not have so high a clay content throughout the profile. They are in positions between Wabash soils and the coarser textured soils along the stream channel.

Typical pedon in an area of Wabash silty clay, 1,280 feet east and 30 feet south of the center of sec. 10, T. 46 N., R. 27 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay; weak very fine subangular blocky structure; firm; common roots; slightly acid; abrupt smooth boundary.

A12—7 to 15 inches; black (10YR 2/1) silty clay; moderate very fine subangular blocky structure; very firm; common roots; medium acid; gradual smooth boundary.

B2—15 to 42 inches; black (10YR 2/1) silty clay; moderate fine subangular blocky structure; very firm to extremely firm; common fine roots; slightly acid; gradual smooth boundary.

B3—42 to 51 inches; black (10YR 2/1) silty clay; weak very fine subangular blocky structure; very firm; very small black concretions; few ground snail shells; few fine roots; neutral; gradual smooth boundary.

C—51 to 66 inches; black (10YR 2/1) silty clay; weak very fine subangular blocky structure; very firm; common snail shells; neutral.

Thickness of the solum ranges from 40 to 60 inches or more, and depth to free carbonates is more than 40 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 2 or less. It is dominantly silty clay but ranges to silty clay loam or silt loam. The matrix of the B horizon, to a depth of 36 inches or more, has the same range in color as the A horizon. Below a depth of 36 inches, the matrix has hue of 10YR, value of 2 through 4, and chroma of 2 or 3. The B horizon has mottles with hue of 10YR through 7.5YR, value of 4 through 6, and chroma of 4 through 6. Mottles of high chroma are common in the upper part of the solum, and mottles of low chroma are mixed throughout the profile. The 10- to 40-inch control section averages 46 to 60 percent clay. The B horizon ranges from medium acid to neutral in the upper part and slightly acid to mildly alkaline in the lower part.

Weller series

This series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slopes are 2 to 5 percent.

Weller soils are similar to Winfield soils and are commonly adjacent to Winfield, Macksburg, and Mandeville soils. Winfield soils are coarser textured throughout the profile and are on the more sloping ridge points and the upper parts of side slopes below Weller soils. Macksburg soils are somewhat poorly drained, have a thick mollic epipedon, and are in areas where the ridgetops become broader. Mandeville soils are well drained to moderately well drained, are coarser textured throughout the profile, and are moderately deep. Mandeville soils are on lower, more sloping side slopes below Weller soils.

Typical pedon in an area of Weller silt loam, 2 to 5 percent slopes, 50 feet south and 400 feet east of the northwest corner of sec. 7, T. 47 N., R. 27 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak very fine granular structure; very friable; many fine roots; few fine concretions; neutral; abrupt smooth boundary.

A21—8 to 12 inches; brown (10YR 5/3) silt loam; few fine faint grayish brown (10YR 5/2) mottles; dark grayish brown (10YR 4/2) on some ped faces; thin moderate platy structure breaking to weak fine granular; very friable; many roots; many fine pores; few fine concretions; neutral; abrupt smooth boundary.

A22—12 to 16 inches; grayish brown (10YR 5/2) silty clay loam; fine moderate subangular blocky structure; friable; many fine roots; common fine pores; few fine concretions; slightly acid; clear smooth boundary.

B1—16 to 22 inches; brown (10YR 5/3) silty clay loam that has common fine grayish brown (10YR 5/2) mottles; fine strongly subangular blocky structure; friable; few fine roots; hard black concretions (2 to 5 millimeters); many fine root pores; strongly acid; abrupt smooth boundary.

B21t—22 to 34 inches; brown (10YR 5/3) silty clay; many fine distinct strong brown (7.5YR 5/6) mottles; weak very coarse angular blocky structure; very firm; very few fine roots; few soft black concretions; dark gray (10YR 4/1) and few dark grayish brown thick discontinuous clay skins on ped faces; strongly acid; clear smooth boundary; 48 percent clay.

B22t—34 to 47 inches; grayish brown (10YR 5/2) silty clay loam; few fine prominent reddish brown (10YR 4/4) mottles, common fine faint gray (10YR 5/1) mottles; and common medium distinct yellowish brown (10YR 5/6) mottles; weak very coarse blocky structure; very firm; few fine roots and root pores; dark clay films in root pores; medium acid; gradual smooth boundary.

B3—47 to 76 inches; mottled, grayish brown (10YR 5/2), gray (10YR 5/1), light brownish gray (10YR 6/2), and yellowish brown (10YR 5/6) silty clay loam; very weak blocky structure; firm; many old root pores; soft black concretions; neutral.

The solum is more than 5 feet thick, and free carbonates are rarely encountered.

The A1 horizon, if present, has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. Most pedons have an Ap horizon that has hue of 10YR, value of 4 or 5, and chroma of 1 through 3. The A2 horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The A horizon dominantly is silt loam but ranges to silty clay loam. The B21t horizon has hue of 10YR, value of 4 or 5, and chroma of 2 through 4. Mottles with hue of 7.5YR through 2.5Y, value of 4 or 5, and chroma of 2 through 6 occur throughout the B2 horizon. Most pedons, however, have a mottle-free area below the Ap horizon. The weighted average of the control section is silty clay loam, but in some pedons, the B2 horizon is silty clay. Reaction ranges from very strongly acid in the upper part of the B horizon to neutral in the lower part. The C horizon is mottled gray, brown, or red with hue of 10YR, value of 4 through 6, and chroma of 1 through 3 in the matrix. Mottles of high and low chroma are common.

Winfield series

This series consists of deep, moderately well drained, moderately permeable soils on loess covered uplands. These soils formed in silty, noncalcareous loess. Slopes are 2 to 9 percent.

Winfield soils are similar to Weller soils and commonly are adjacent to Weller, Mandeville, and Norris soils. Weller soils have a finer textured argillic horizon and are in areas where the ridgetop is broader. Mandeville soils formed in silty shale bedrock, are moderately deep, and are on side slopes below Winfield soils. Norris soils are shallow, well drained, steeper, and below Winfield soils.

Typical pedon in an area of Winfield silt loam, 5 to 9 percent slopes, 2,020 feet south and 100 feet east of the northwest corner of sec. 17, T. 47 N., R. 27 W.

Ap1—0 to 3 inches; brown (10YR 4/3) silt loam; weak fine granular structure; very friable; many roots; medium acid; abrupt smooth boundary.

Ap2—3 to 8 inches; mixed dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) silt loam; weak fine granular structure; very friable; many roots; slightly acid; abrupt smooth boundary.

B1—8 to 11 inches; yellowish brown (10YR 5/4) silty clay loam; weak fine subangular blocky structure; very friable; many roots; few black concretions (2 millimeters); slightly acid; abrupt smooth boundary.

B21t—11 to 16 inches; dark yellowish brown (10YR 5/4) silty clay loam; many fine faint dark brown (7.5YR 4/4) mottles; strong fine subangular blocky structure; friable; many roots; few black concretions (2 millimeters); many silt coatings on ped faces; strongly acid; gradual smooth boundary.

B22t—16 to 30 inches; dark brown (10YR 4/3) silty clay loam; few fine faint yellowish brown (10YR 5/6) mot-

tles; weak fine subangular blocky structure; firm; few roots; few black concretions (2 millimeters); many gray (10YR 5/3) silt coatings on ped faces; thick discontinuous clay films; strongly acid; gradual smooth boundary.

B3t—30 to 78 inches; strong brown (7.5YR 5/6) silty clay loam; few fine distinct brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; many fine root pores; few black concretions (2 millimeters); thick discontinuous clay films; medium acid.

Thickness of the solum ranges from 40 to 70 inches or more. The Ap horizon has hue of 10YR, value of 4, and chroma of 2 or 3. A few areas have a 1- to 4-inch A1 horizon that has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. The A2 horizon, if present, has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The B1 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is silt loam or silty clay loam. The B2t horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 through 6. The lower part of the B2t horizon has mottles that have value of 4 through 6 and chroma of 1 through 6. The B3 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 through 6. It has mottles that have chroma of 2 or less and other mottles of higher value and chroma. The B horizon ranges from slightly acid to very strongly acid.

Zook series

This series consists of deep, poorly drained, slowly permeable soils on stream bottom lands. These soils formed in silty and clayey alluvial material. Slopes are 0 to 1 percent.

Zook soils are similar to Wabash soils and commonly are adjacent to Blackoar, Dockery, and Wabash soils. Blackoar and Dockery soils are coarser textured and less developed throughout the profile. These soils typically are in positions between Zook soils and the main stream channel. Wabash soils are finer textured throughout the profile and normally are in depressions or at the base of foot slopes.

Typical pedon in an area of Zook silty clay loam, 900 feet north and 1,000 feet east of the southeast corner of sec. 1, T. 46 N., R. 27 W.

Ap—0 to 15 inches; very dark gray (10YR 3/1) silty clay loam; moderate fine subangular blocky structure; firm; many fine roots; neutral; abrupt smooth boundary.

A12—15 to 22 inches; very dark gray (10YR 3/1) silty clay loam; weak fine subangular blocky structure; firm; many fine roots; slightly acid; abrupt smooth boundary.

B21g—22 to 33 inches; very dark gray (10YR 3/1) silty clay; weak fine subangular structure; firm; many very fine roots and root pores; slightly acid; gradual smooth boundary.

B22g—33 to 60 inches; very dark gray (10YR 3/1) silty clay; very weak fine subangular blocky structure; very firm; prominent fine yellowish brown (10YR 5/6) mottles; fine roots and root pores; mildly alkaline; gradual smooth boundary.

Cg—60 to 90 inches; dark gray (10YR 4/1) silty clay; massive; firm; common medium yellowish brown (10YR 5/6) mottles; few very fine roots; mildly alkaline.

Thickness of the solum ranges from 36 to 64 inches. Thickness of the mollic epipedon ranges from 36 to 60 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or less. It is silty clay loam or silty clay that averages 32 to 42 percent clay. The B horizon has hue of 10YR, value of 3 or 4, and chroma of 1. Some pedons have mottles that have high chroma and value in the lower part of the B horizon and in the C horizon. The B2 horizon is silty clay that averages 38 to 42 percent clay.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*22*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 19, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiaquolls (*Argi*, meaning clay accumulation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Typic Agriaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Formation of the soils

This section describes the factors of soil formation, relates them to the formation of soils in the survey area, and explains the process of soil formation.

Factors of soil formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material (*21*).

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil that has distinct horizons. Although it varies in length, time is always required for differentiation of soil horizons. Generally a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Plants and animals

Plants, burrowing animals, insects, bacteria, and fungi are important in the formation of soils. They affect the organic matter content, plant nutrients, structure, and porosity of soils.

Many of the soils in Johnson County formed when the vegetation was mainly tall prairie grasses. These soils, generally known as "prairie soils," have a thick, dark surface layer that is high in organic matter because of abundant bacteria and decay of the fine grass roots. Soils that formed under this plant cover are in the Barco, Bremer, Deepwater, Macksburg, Polo, Sampsel, and Sharpsburg series.

Deciduous forests and their associated plant and animal life formed soils that have a light colored surface layer and low organic matter content. Only about one-fourth of the area of Johnson County formed under forest vegetation alone; however, a large area of the soils formed under prairie vegetation and then under forest vegetation. Such soils have a surface layer that is lighter than prairie soils and somewhat darker colored than forest soils. Soils that formed under forest vegetation in Johnson County are in the Bolivar, Gorin, Mandeville, Weller and Winfield series.

Micro-organisms reduce organic matter to humus. The release of plant nutrients and the fixation of atmospheric nitrogen by nodule bacteria are examples of the contributions that micro-organisms make to soil formation and plant growth. Earthworms, insects, and burrowing animals also have a favorable effect on tilth, fertility, and drainage.

Man also has had an influence on soil formation. Soil in many places has been tilled and used for intensive cropping. Grain and forage residue has been removed from the soil and used as feed and forage. Chemical sprays are often used to reduce the growth of some residue-producing plants and to help control insects and pests. These practices tend to leave the soil surface bare of protective cover and permit erosion of the surface layer. A significant acreage of the soils in Johnson County has been eroded.

Climate

Climate, both long ago and recently, has been an important factor in the formation of soils in Johnson

County. As a result of the climate of long ago, soil forming materials were deposited in the county by ice, wind, and water. More recent climate has affected, either directly or indirectly, the development of soils that formed from these and other materials. Geologic erosion, plant and animal life, and in more recent time, accelerated erosion have varied with the climate and changes have influenced soil development.

Climate largely determines the rate of weathering of soils, and it also influences the type of vegetation that grows on soils. Johnson County has a temperate, humid, continental climate. The average precipitation is about 39 inches (*13*), and the frost-free growing season averages 166 days (*8*). The prevailing winds are from the south or southwest. These winds are generally warm and moist, but in most years, between mid-July and September, they are hot and dry and rainfall is limited. Short periods of excessive rainfall are common in spring, fall, or both. The soils are frozen for short periods in winter, and soil formation processes are slowed. In most places the average annual temperature of the soil at a depth of 20 inches is about 59 degrees F.

The humid climate of Johnson County is conducive to the relatively rapid breakdown of minerals for the formation of clay and the translocation of those materials downward in the soil profile. The subsoil of the Haig and Hartwell soils is high in clay content. These soils, therefore, have very slow to slow permeability in the subsoil, which causes excess wetness during seasons of highest rainfall. Conversely, the low available water capacity of their subsoils causes droughtiness during hot summer months when rainfall is low.

Parent material

Parent material is the unconsolidated mass from which a soil is formed. It determines the limits of the chemical and mineral composition of the soil. In Johnson County three kinds of parent material, alone or in combinations of two or more, have contributed to the formation of soils. These are residual or bedrock material, loess or wind-deposited material, and alluvial or water-deposited material.

Residual material weathered from limestone, sandstone, and shale to form the parent material of such soils as Barco, Mandeville, Norris, and Snead soils.

Loess parent material, principally made up of silts, was transported into Johnson County by wind. The Haig, Higginsville, and Macksburg soils formed in this material.

Alluvial parent material in Johnson County is of local origin. It is made up of silt, sand, clay, and gravel and is transported by water from the uplands to the flood plains of streams. Soils, such as Blackoar, Nodaway, and Zook soils, formed in alluvium deposited by the Blackwater River and other local streams.

Relief

Relief, or topography, affects soil formation through its influence on drainage, runoff, infiltration, and other related factors, including accelerated erosion. In areas that have about the same plant cover and rainfall, runoff is rapid on steep slopes and is slower or absent in nearly level areas. In areas where most of the water runs off, little water enters the soil and it forms slowly. In these areas, soil horizons are indistinct and the solum is thin. The Snead soil is an example. In areas where little water runs off, or where it runs off slowly, more water enters the soil and it forms rapidly. In these areas, soil horizons are distinct and the solum is thick. An example is the Hartwell soil.

Time

In addition to the factors of parent material, climate, plant and animal life, and relief, time has played an important role in soil development in Johnson County. Some time is always required to convert parent material to soil. A long time is required to produce a mature soil, and a relatively short time is required for a young soil to acquire distinct characteristics.

Nodaway soils are one of the youngest soils in the county. The material in which these soils formed washed from nearby uplands and was deposited by the local streams. In places of extreme erosion and deposition, 30 to 40 inches or more of this material probably was deposited in as little as one year. Horizons within the Nodaway soils are not distinct. The upper 9 inches of these soils are only slightly different from the rest of the profile. The main difference is the absence of depositional strata in the upper part; also a weak, fine, granular structure has developed. These differences are most likely a result of tillage and the incorporation of residue in the upper 9 inches in relatively recent years.

Examples of old or mature soils in the county are the Hartwell and Lightning soils. These soils have a well developed subsoil that is high in clay content and strikingly different from the adjacent upper and lower layers. The soils developed in areas of subnormal relief. Runoff was slow, and the soils remained wet during most of the year. Erosion on areas under native prairie grasses was negligible. Water that did not evaporate or run off moved downward through the soils.

The subnormal relief and excess water hastened the process of soil formation, and in time the clay particles moved from the surface layer down into the lower layers. This translocation of clay resulted in the accumulation of dark clay immediately below a bleached, severely leached, silty subsurface layer. Relief, and its influence on local climate, was a very significant factor in the formation and development of these soils. The length of time required for the development of mature soils was considerably shortened.

Other soils in the county, such as the Barco, Norris, and Bolivar soils, have been in place as long as Haig and Hartwell soils and have had equal time for development. These soils, however, have thin or weak horizon development and are considered to be youthful or immature soils. Differences in parent material, animal life, and relief have apparently been the dominant factors in development. A much longer time is required for these soils to develop to maturity.

Other soils in the county range in profile development from fairly youthful to fairly old. An example of an older soil is the Haig soils, which have developed a fairly heavy subsoil. A fairly youthful profile is represented by the Mandeville soils, which have a relatively thin, medium textured subsoil. In both of these soils, the particular stage of profile development is an expression of the interrelationship of the various factors of soil formation.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Austin, Morris E. 1965. Land resource regions and major land resource areas of the United States. U.S. Dep. Agric. Handb. 296, 82 pp., map.

(4) Brendemuehl et al. 1961. Stand, yield, and growth of silver maple in Iowa. ISU-F-159.

(5) Broadfoot, W. M. and R. M. Krinard, 1959. Guide for evaluating sweetgum sites. U.S. Dep. Agr., Forest Serv., South. Forest Exp. Stn. Occas. Pap. 176, 8 pp., illus.

(6) Broadfoot, W. M. 1960. Field guide for evaluating cottonwood sites. U.S. Dep. Agric., Forest Serv., South. Forest Exp. Stn. Occas. Pap. 178, 6 pp., illus.

(7) Broadfoot, W. M. 1963. Guide for evaluating water oak sites. U.S. Dep. Agric., Forest Serv., South. Forest Exp. Stn. Res. Pap. SO-1, 8 pp., illus.

(8) Decker, Wayne L. 1955. Late spring and early killing freezes in Missouri. Mo. Agric. Exp. Stn. Bull. 649, 15 pp., illus.

(9) Department of Natural Resources, Division of Parks and Recreation. 1976. Missouri statewide comprehensive outdoor recreation plan. (SCORP).

(10) Essex, Burton L. 1974. Forest area in Missouri counties, 1972. U.S. Dep. Agric., Forest Serv. Res. Note NO-182.

(11) Kansas City, Missouri Historical Company. 1881. History of Johnson County, Missouri. [Reprinted 1970]

(12) Kellogg, L. F. 1939. Site index curves for black walnut, Central States. Cent. States Forest Exp. Stn. Tech. Note No. 35.

(13) Missouri Agricultural Experiment Station. [n.d.]. Monthly precipitation in Missouri. Climatic Atlas of Missouri No. 1. Mo. Agric. Exp. Stn. Bull. 650, 68 pp., illus.

(14) Missouri Bureau of Outdoor Recreation. 1974. NACD nationwide outdoor recreation inventory.

(15) Missouri Conservation Needs Inventory Committee. 1970. Missouri soil and water conservation needs inventory. 196 pp.

(16) Missouri Division of Geological Survey and Water Resources. 1963. Water quality map and ground water areas of Missouri.

(17) Nagel, Werner O. 1970. Conservation contrasts. Mo. Dep. Conserv., 453 pp., illus.

(18) Portland Cement Association. 1962. PCA soil primer. 52 pp., illus.

(19) Schnur, G. Luther. 1937. Yield, stand, and volume tables for even-aged upland oak forest. U.S. Dep. Agric. Tech. Bull. 560, 88 pp., illus. [Reprinted 1961]

(20) State Interagency Council for Outdoor Recreation. 1970. Missouri statewide comprehensive outdoor recreation plan. (SCORP). Vol. 2, Dec. 1970.

(21) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(22) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock. Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Light textured soil. Sand and loamy sand.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, differences in slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Polypedon. A volume of soil having properties within the limits of a soil series, the lowest and most homogeneous category of soil taxonomy. A "soil individual."

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in di-

ameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	Less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is

generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress road-banks, lawns, and land affected by mining.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Wilting point (or permanent wilting point). The moisture content of soil, on an overdry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-74 at Warrensburg, Missouri]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	40.2	21.2	30.7	68	-7	0	1.37	.45	2.10	3	3.4
February---	46.1	26.0	36.1	72	-1	10	1.47	.62	2.14	4	2.8
March------	55.4	33.3	44.4	84	7	89	2.85	1.28	4.12	6	3.6
April------	69.0	45.7	57.4	88	25	244	4.11	1.91	5.89	7	.5
May--------	77.7	55.6	66.7	91	36	518	4.56	3.04	5.95	7	.0
June-------	85.5	64.2	74.9	98	48	747	5.02	2.25	7.26	7	.0
July-------	90.5	68.2	79.4	104	54	911	4.41	1.89	6.46	6	.0
August-----	89.6	66.6	78.1	101	51	871	3.41	.87	5.43	5	.0
September--	82.3	58.9	70.6	98	41	618	4.29	1.52	6.51	6	.0
October----	71.6	48.7	60.1	91	27	331	3.61	1.19	5.53	5	.0
November---	55.7	36.0	45.9	77	12	50	1.73	.45	2.75	4	1.0
December---	43.7	26.3	35.0	68	-1	12	1.79	.88	2.53	4	4.3
Year-----	67.3	45.9	56.6	104	-9	4,401	38.62	29.66	47.58	64	15.6

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-74 at Warrensburg, Missouri]

Probability	Temperature 24° F or lower	Temperature 28° F or lower	Temperature 32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 7	April 16	April 21
2 years in 10 later than--	March 31	April 11	April 17
5 years in 10 later than--	March 19	April 3	April 9
First freezing temperature in fall:			
1 year in 10 earlier than--	October 30	October 23	October 15
2 years in 10 earlier than--	November 5	October 28	October 19
5 years in 10 earlier than--	November 17	November 5	October 28

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-74 at Warrensburg, Missouri]

Probability	Daily minimum temperature during growing season: Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	213	196	182
8 years in 10	223	203	189
5 years in 10	242	215	201
2 years in 10	261	228	213
1 year in 10	271	235	219

TABLE 4.--POTENTIALS AND LIMITATIONS OF ASSOCIATIONS ON THE GENERAL SOIL MAP FOR SPECIFIED USES

Association	Extent of area	Cultivated crops	Specialty crops	Woodland	Urban uses	Intensive recreation areas	Extensive recreation areas
	Pct						
Macksburg-Sampsel	8	Good	Good	Poor: wetness.	Poor: wetness, shrink-swell.	Fair: wetness.	Fair: wetness.
Sampsel-Snead-Polo	26	Good	Good	Fair: wetness.	Poor: wetness, depth to rock, shrink-swell.	Poor: wetness, slope.	Fair: wetness.
Mandeville-Norris-Bolivar	15	Poor: depth to rock.	Poor: depth to rock.	Fair: depth to rock.	Fair: depth to rock, slope.	Poor: slope.	Fair: wetness.
Sampsel-Deepwater-Haig	40	Good	Good	Poor: wetness.	Poor: wetness, shrink-swell, too clayey.	Poor: wetness.	Fair: wetness.
Zook-Dockery-Blackoar	11	Fair: floods.	Good	Fair: wetness.	Poor: floods, low strength.	Poor: floods.	Fair: floods.

TABLE 5.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
BaB	Barco loam, 2 to 5 percent slopes	2,150	0.4
BaC	Barco loam, 5 to 9 percent slopes	8,900	1.7
Bk	Blackoar silt loam	10,100	1.9
BoC2	Bolivar loam, 5 to 9 percent slopes, eroded	7,700	1.5
BoD2	Bolivar fine sandy loam, 9 to 14 percent slopes, eroded	4,750	0.9
Br	Bremer silty clay loam	4,950	0.9
DpB	Deepwater silt loam, 2 to 5 percent slopes	21,150	4.0
DpC2	Deepwater silt loam, 5 to 9 percent slopes, eroded	32,400	6.1
Dt	Dockery silty clay loam	11,400	2.2
Fs	Freeburg silt loam	4,450	0.8
GoC2	Gorin silt loam, 5 to 9 percent slopes, eroded	15,900	3.0
Hg	Haig silt loam	28,250	5.3
Hp	Haplaquents-Urban land complex	1,650	0.3
HtA	Hartwell silt loam, 0 to 2 percent slopes	11,200	2.1
HtB2	Hartwell silt loam, 2 to 5 percent slopes, eroded	12,900	2.4
HxC	Higginsville silt loam, 4 to 7 percent slopes	7,000	1.3
Ka	Kanima shaly silty clay loam, 30 to 60 percent slopes	860	0.2
Lg	Lightning silt loam	4,450	0.8
MaB	Macksburg silt loam, 1 to 4 percent slopes	29,500	5.6
MdB	Mandeville silt loam, 2 to 5 percent slopes	1,550	0.3
MdC	Mandeville silt loam, 5 to 9 percent slopes	34,000	6.4
Nd	Nodaway silt loam	22,900	4.4
NoD	Norris shaly silt loam, 5 to 14 percent slopes	16,400	3.1
NoF	Norris shaly silt loam, 14 to 35 percent slopes	7,100	1.3
Pd	Pits, quarries	380	0.1
PoB	Polo silt loam, 2 to 5 percent slopes	17,250	3.3
PoC2	Polo silt loam, 5 to 9 percent slopes, eroded	7,300	1.4
SaB	Sampsel silty clay loam, 2 to 5 percent slopes	29,500	5.6
SaC	Sampsel silty clay loam, 5 to 9 percent slopes	3,650	0.7
SaC3	Sampsel silty clay loam, 5 to 9 percent slopes, severely eroded	84,500	16.0
ShB	Sharpsburg silt loam, 2 to 5 percent slopes	1,350	0.3
SnD2	Snead silty clay loam, 7 to 16 percent slopes, eroded	21,900	4.1
SoD	Snead-Rock outcrop complex, 5 to 14 percent slopes	10,500	2.0
SoF	Snead-Rock outcrop complex, 14 to 35 percent slopes	9,300	1.8
Wa	Wabash silty clay	4,700	0.9
WdB	Weller silt loam, 2 to 5 percent slopes	9,600	1.8
WfB	Winfield silt loam, 2 to 5 percent slopes	2,350	0.4
WfC	Winfield silt loam, 5 to 9 percent slopes	2,300	0.4
WfC3	Winfield silty clay loam, 5 to 9 percent slopes, severely eroded	350	0.1
Zk	Zook silty clay loam	18,800	3.6
	Water	3,300	0.6
	Total	528,640	100.0

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or that the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Grain sorghum	Winter wheat	Grass-legume hay	Tall fescue
	Bu	Bu	Bu	Bu	Ton	AUM*
BaB Barco	72	26	61	30	3.3	6.6
BaC Barco	66	24	55	27	3.0	6.2
Bk Blackoar	100	37	88	42	4.4	9.0
BoC2 Bolivar	48	16	39	20	2.5	5.0
BoD2 Bolivar	---	---	---	---	2.0	4.0
Br Bremer	96	36	83	40	4.3	8.6
DpB Deepwater	102	38	88	42	4.5	9.0
DpC2 Deepwater	90	34	77	37	4.0	8.0
Dt Dockery	85	31	73	35	3.7	7.4
Fs** Freeburg	92	35	77	38	4.0	8.0
GoC2 Gorin	55	20	45	23	2.6	5.0
Hg Haig	96	40	83	40	4.2	8.6
Hp Haplaquents-Urban land	---	---	---	---	---	---
HtA Hartwell	86	32	72	35	3.7	7.4
HtB2 Hartwell	70	25	65	30	3.5	7.0
HxC Higginsville	103	38	88	42	4.5	9.0
Ka Kanima	---	---	---	---	.8	1.6
Lg Lightning	72	26	61	30	3.3	6.6
MaB Macksburg	110	44	96	46	4.8	9.6
MdB Mandeville	67	25	55	27	3.0	6.0
MdC Mandeville	60	21	50	25	2.7	5.4

See footnotes at end of table.

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Grain sorghum	Winter wheat	Grass-legume hay	Tall fescue
	Bu	Bu	Bu	Bu	Ton	AUM*
Nd----------------------- Nodaway	96	36	83	40	4.3	8.6
NoD---------------------- Norris	---	---	---	---	1.3	2.6
NoF---------------------- Norris	---	---	---	---	.8	1.6
Pd***. Pits, quarries						
PoB---------------------- Polo	96	36	83	40	4.3	8.0
PoC2--------------------- Polo	84	30	72	35	3.7	7.4
SaB---------------------- Sampsel	89	33	77	37	4.0	8.0
SaC---------------------- Sampsel	82	30	70	33	3.7	7.4
SaC3--------------------- Sampsel	72	24	61	30	3.4	6.9
ShB---------------------- Sharpsburg	101	43	88	42	4.5	9.0
SnD2--------------------- Snead	---	---	---	---	2.3	4.2
SoD---------------------- Snead-Rock outcrop	---	---	---	---	1.5	3.0
SoF---------------------- Snead-Rock outcrop	---	---	---	---	.9	1.8
Wa----------------------- Wabash	62	21	50	25	2.7	5.4
WdB---------------------- Weller	82	30	70	35	3.7	7.4
WfB---------------------- Winfield	98	38	85	40	4.3	8.6
WfC---------------------- Winfield	92	36	77	40	4.1	8.0
WfC3--------------------- Winfield	74	28	68	32	3.4	7.2
Zk----------------------- Zook	82	36	72	32	3.5	6.6

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** Yields are for areas protected from flooding.
*** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
Bk: Blackoar	3w	Slight	Severe	Moderate	Severe	Pin oak	80	Pin oak, eastern cottonwood, pecan.
						Eastern cottonwood	95	
BoC2, BoD2: Bolivar	4o	Slight	Slight	Slight	Slight	White oak	57	White oak, green ash, shortleaf pine.
						Black oak	---	
						Northern red oak	---	
						Black walnut	---	
Br: Bremer	3w	Slight	Severe	Moderate	Severe	Eastern cottonwood	90	American sycamore, common hackberry, green ash, eastern cottonwood, silver maple, northern white-cedar.
						Silver maple	80	
DpB, DpC2: Deepwater	2o	Slight	Slight	Slight	Slight	Pin oak	86	Pin oak, pecan.
						Pecan	60	
Dt: Dockery	3w	Slight	Slight	Slight	Moderate	Pin oak	76	Pin oak, pecan, eastern cottonwood.
Fs: Freeburg	3o	Slight	Slight	Slight	Slight	White oak	65	White oak, pin oak, green ash, eastern cottonwood, yellow-poplar, black oak, eastern redcedar, pecan.
GoC2: Gorin	4c	Slight	Slight	Moderate	Slight	White oak	55	White oak, green ash, yellow-poplar, pin oak, black oak, eastern redcedar, red pine.
						Black oak	---	
						Northern red oak	---	
						Pin oak	---	
Lg: Lightning	3w	Slight	Slight	Slight	Moderate	Pin oak	---	Pecan, green ash, eastern cottonwood, bur oak.
						Pecan	---	
						Eastern cottonwood	90	
						Green ash	---	
						Bur oak	---	
MdB, MdC: Mandeville	4o	Slight	Slight	Slight	Slight	White oak	60	Black walnut, yellow-poplar, sweetgum.
						Black walnut	---	
						Black oak	---	
						Shagbark hickory	---	
						White ash	---	
Nd: Nodaway	2o	Slight	Slight	Slight	Moderate	White oak	65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
NoD: Norris	5d	Moderate	Slight	Moderate	Slight	White oak	49	Shortleaf pine, white oak, eastern white pine.
						Black oak	---	
						Northern red oak	---	

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
NoF----------------- Norris	5d	Severe	Moderate	Moderate	Slight	White oak------------ Black oak------------ Northern red oak----	49 --- ---	Shortleaf pine, white oak, eastern white pine.
ShB----------------- Sharpsburg	4o	Slight	Slight	Slight	Slight	Black oak------------ Black walnut--------- White oak------------ Common hackberry---- Green ash------------	60 60 --- --- ---	Black walnut, common hackberry, green ash.
Wa------------------ Wabash	4w	Slight	Severe	Severe	Severe	Pin oak--------------	75	Pin oak, pecan, eastern cottonwood.
WdB----------------- Weller	4o	Slight	Slight	Slight	Slight	White oak------------	55	Eastern white pine, Scotch pine, Norway spruce, white spruce, red pine, European larch, black walnut, sugar maple.
WfB, WfC, WfC3------ Winfield	3o	Slight	Slight	Slight	Slight	White oak------------ Black oak------------ Northern red oak---- Black walnut---------	65 --- --- ---	Scotch pine, green ash, black walnut, yellow-poplar.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; the symbol > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
BaB, BaC: Barco	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar, Russian-olive, black locust.	Austrian pine, Scotch pine, eastern white pine, ponderosa pine, green ash.	---
Bk: Blackoar	Silky dogwood	Amur honeysuckle, medium purple willow.	Norway spruce, Amur maple, eastern redcedar.	Pin oak, green ash, American sycamore.	Silver maple, eastern cottonwood, European alder.
BoC2, BoD2: Bolivar	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple, Russian-olive, black locust.	Green ash, Austrian pine, eastern white pine, Scotch pine, ponderosa pine.	---
Br: Bremer	Silky dogwood	Amur honeysuckle, medium purple willow.	Eastern redcedar, Norway spruce, Amur maple.	Green ash, pin oak, American sycamore.	Silver maple, eastern cottonwood, European alder.
DpB, DpC2: Deepwater	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar.	Austrian pine, Norway spruce, green ash, Scotch pine.	European alder, eastern white pine, eastern cottonwood.
Dt: Dockery	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar.	Green ash, Austrian pine, Scotch pine, red pine, pin oak.	Eastern cottonwood, eastern white pine.
Fs: Freeburg	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Scotch pine, red pine, pin oak, green ash, Austrian pine.	Eastern white pine, eastern cottonwood.
GoC2: Gorin	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Red pine, pin oak, green ash, Austrian pine, Scotch pine.	Eastern white pine, eastern cottonwood.
Hg: Haig	Silky dogwood	Amur honeysuckle, medium purple willow.	Eastern redcedar, Norway spruce, Amur maple.	Green ash, American sycamore, pin oak.	Silver maple, eastern cottonwood, European alder.
Hp*: Haplaquents.					
Urban land.					
HtA, HtB2: Hartwell	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar.	Scotch pine, Austrian pine, green ash, red pine, pin oak.	Eastern cottonwood, eastern white pine.
HxC: Higginsville	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Austrian pine, pin oak, Scotch pine, green ash, red pine.	Eastern cottonwood, eastern white pine.
Ka: Kanima	Cutleaf staghorn sumac.	Amur honeysuckle, autumn-olive.	Russian-olive, eastern redcedar, black locust, common hackberry.	American sycamore, Siberian elm, green ash, Scotch pine.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Lg: Lightning	Silky dogwood	Amur honeysuckle, medium purple willow.	Norway spruce, Amur maple, eastern redcedar.	Pin oak, green ash, American sycamore.	Silver maple, eastern cottonwood, European alder.
MaB: Macksburg	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Pin oak, red pine, Scotch pine, green ash, Austrian pine.	Eastern white pine, eastern cottonwood.
MdB, MdC: Mandeville	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar, Russian-olive, black locust.	Green ash, ponderosa pine, Scotch pine, Austrian pine.	Eastern white pine.
Nd: Nodaway	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar.	Red pine, Norway spruce, green ash, Scotch pine.	Eastern white pine, pin oak, yellow poplar.
NoD, NoF: Norris	Cutleaf staghorn sumac.	Amur honeysuckle, autumn-olive.	Eastern redcedar, black locust, Russian-olive, common hackberry.	Green ash, Siberian elm, American sycamore, Scotch pine.	Eastern cottonwood.
Pd*. Pits, quarries					
PoB, PoC2: Polo	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar.	Austrian pine, Norway spruce, green ash, Scotch pine.	European alder, eastern white pine, eastern cottonwood.
SaB, SaC, SaC3: Sampsel	Silky dogwood	Amur honeysuckle, autumn-olive.	Amur maple, eastern redcedar.	Pin oak, green ash, Austrian pine, red pine, Scotch pine.	Eastern cottonwood, eastern white pine.
ShB: Sharpsburg	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Scotch pine, red pine, Norway spruce, green ash.	Eastern white pine, pin oak, yellow poplar.
SnD2: Snead	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, black locust, Amur maple, Russian-olive.	Scotch pine, ponderosa pine, green ash, Austrian pine, eastern white pine.	---
SoD*, SoF*:					
Snead	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple, black locust, Russian-olive.	Scotch pine, Austrian pine, eastern white pine, ponderosa pine, green ash.	---
Rock outcrop.					
Wa: Wabash	Silky dogwood	Medium purple willow, Amur honeysuckle.	Norway spruce, eastern redcedar, American basswood, Amur maple.	Green ash, pin oak, American sycamore.	Eastern cottonwood, European alder, silver maple.
WdB: Weller	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Scotch pine, green ash, Austrian pine, Norway spruce.	Eastern white pine, European alder, eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
WfB, WfC, WfC3: Winfield	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, green ash, Scotch pine.	Eastern white pine, yellow-poplar, pin oak.
Zk: Zook	Silky dogwood	Amur honeysuckle, medium purple willow.	Norway spruce, Amur maple, eastern redcedar.	Green ash, pin oak, American sycamore.	Silver maple, eastern cottonwood, European alder.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
BaB: Barco	Moderate: depth to rock.	Moderate: shrink-swell, low strength.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, low strength.	Severe: low strength.
BaC: Barco	Moderate: depth to rock.	Moderate: shrink-swell, low strength.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope, low strength.	Severe: low strength.
Bk: Blackoar	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, low strength, wetness.
BoC2: Bolivar	Moderate: depth to rock.	Moderate: shrink-swell, low strength.	Moderate: depth to rock.	Moderate: shrink-swell, slope, low strength.	Severe: low strength.
BoD2: Bolivar	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope, low strength.	Moderate: depth to rock, slope.	Severe: slope.	Severe: low strength.
Br: Bremer	Severe: wetness.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.
DpB: Deepwater	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, low strength.	Severe: low strength.
DpC2: Deepwater	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope, low strength.	Severe: low strength.
Dt: Dockery	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: frost action, floods, low strength.
Fs: Freeburg	Severe: wetness.	Severe: floods.	Severe: wetness, floods.	Severe: floods.	Severe: low strength, frost action.
GoC2: Gorin	Moderate: too clayey, wetness.	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Hg: Haig	Severe: wetness, too clayey.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.
Hp*:					
Haplaquents.					
Urban land.					

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
HtA, HtB2: Hartwell	Severe: wetness.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: low strength, shrink-swell.
HxC: Higginsville	Moderate: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: frost action.
Ka: Kanima	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Lg: Lightning	Severe: wetness, floods, too clayey.	Severe: floods, shrink-swell, low strength.	Severe: low strength, floods, shrink-swell.	Severe: low strength, floods, shrink-swell.	Severe: low strength, floods, shrink-swell.
MaB: Macksburg	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.
MdB: Mandeville	Moderate: depth to rock.	Moderate: low strength.	Moderate: depth to rock.	Moderate: low strength.	Severe: low strength.
MdC: Mandeville	Moderate: depth to rock.	Moderate: low strength.	Moderate: depth to rock.	Moderate: slope, low strength.	Severe: low strength.
Nd: Nodaway	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action.
NoD: Norris	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock, slope.	Moderate: depth to rock, slope, frost action.
NoF: Norris	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.
Pd*. Pits, quarries					
PoB, PoC2: Polo	Moderate: too clayey.	Severe: low strength.	Severe: shrink-swell, low strength.	Severe: low strength.	Severe: low strength.
SaB, SaC, SaC3: Sampsel	Severe: wetness.	Severe: shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: frost action, low strength, shrink-swell.
ShB: Sharpsburg	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
SnD2: Snead	Severe: depth to rock.	Severe: shrink-swell.	Severe: depth to rock, wetness.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
SoD*: Snead	Severe: large stones, depth to rock.	Severe: large stones.	Severe: depth to rock, wetness.	Severe: large stones, slope.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
SoD*:					
Rock outcrop.					
SoF*:					
Snead	Severe: large stones, slope, depth to rock.	Severe: large stones, slope.	Severe: depth to rock, slope, wetness.	Severe: large stones, slope.	Severe: shrink-swell, low strength, slope.
Rock outcrop.					
Wa: Wabash	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, low strength.
WdB: Weller	Severe: wetness, too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, frost action, low strength.
WfB: Winfield	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
WfC: Winfield	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, slope, low strength.	Severe: frost action, low strength.
WfC3: Winfield	Moderate: slope.	Moderate: shrink-swell, slope, low strength.	Moderate: shrink-swell, wetness, slope.	Severe: slope.	Severe: frost action, low strength.
Zk: Zook	Severe: wetness, floods, too clayey.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, low strength, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
BaB, BaC Barco	Severe: depth to rock.	Moderate: depth to rock, slope.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Bk Blackoar	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
BoC2 Bolivar	Severe: depth to rock.	Moderate: seepage, slope, depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
BoD2 Bolivar	Severe: depth to rock.	Severe: slope.	Severe: depth to rock.	Moderate: slope, depth to rock.	Poor: area reclaim.
Br Bremer	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness.
DpB, DpC2 Deepwater	Severe: wetness.	Severe: wetness.	Moderate: too clayey, wetness.	Slight	Fair: too clayey, wetness.
Dt Dockery	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor. wetness.
Fs Freeburg	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
GoC2 Gorin	Severe: percs slowly, wetness.	Moderate: slope.	Severe: wetness, too clayey.	Moderate: wetness.	Poor: too clayey.
Hg Haig	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness, too clayey.
Hp*: Haplaquents.					
Urban land.					
HtA Hartwell	Severe: percs slowly, wetness.	Slight	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness.
HtB2 Hartwell	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness.
HxC Higginsville	Severe: percs slowly, wetness.	Moderate: slope.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey.
Ka Kanima	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Lg------------------- Lightning	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, too clayey.	Severe: wetness, floods.	Poor: too clayey.
MaB------------------ Macksburg	Severe: percs slowly, wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Fair: too clayey.
MdB, MdC------------- Mandeville	Severe: depth to rock.	Moderate: depth to rock, seepage, slope.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Nd------------------- Nodaway	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
NoD------------------ Norris	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
NoF------------------ Norris	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Poor: area reclaim, slope.
Pd*. Pits, quarries					
PoB, PoC2------------ Polo	Slight------------	Moderate: slope, seepage.	Moderate: too clayey.	Slight------------	Fair: too clayey.
SaB, SaC, SaC3------- Sampsel	Severe: percs slowly, wetness.	Severe: wetness.	Severe: too clayey, wetness.	Moderate: wetness.	Poor: too clayey.
ShB------------------ Sharpsburg	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight------------	Fair: too clayey.
SnD2----------------- Snead	Severe: wetness, depth to rock.	Severe: slope, depth to rock, wetness.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
SoD*:					
Snead----------------	Severe: depth to rock, wetness.	Severe: slope, wetness, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock.	Poor: area reclaim.
Rock outcrop.					
SoF*:					
Snead----------------	Severe: depth to rock, wetness, slope.	Severe: slope, wetness, large stones.	Severe: depth to rock, large stones.	Severe: slope, depth to rock.	Poor: area reclaim, slope.
Rock outcrop.					
Wa------------------- Wabash	Severe: percs slowly, floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
WdB------------------ Weller	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
WfB, WfC------------ Winfield	Severe: wetness.	Severe: wetness.	Moderate: too clayey, wetness.	Slight-----------	Fair: too clayey, wetness.
WfC3---------------- Winfield	Severe: wetness.	Severe: slope.	Moderate: too clayey, wetness.	Moderate: slope.	Fair: too clayey, wetness, slope.
Zk------------------ Zook	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: too clayey, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
BaB, BaC: Barco	Poor: low strength, thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Bk: Blackoar	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
BoC2: Bolivar	Poor: low strength, thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
BoD2: Bolivar	Poor: low strength, thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
Br: Bremer	Poor: shrink-swell, frost action, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
DpB, DpC2: Deepwater	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Dt: Dockery	Poor: frost action, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Fs: Freeburg	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	
GoC2: Gorin	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Hg: Haig	Poor: shrink-swell, wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Hp*: Haplaquents.				
Urban land.				
HtA, HtB2: Hartwell	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
HxC: Higginsville	Fair: wetness, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Ka: Kanima	Poor: slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope, small stones.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Lg----------------------- Lightning	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
MaB---------------------- Macksburg	Poor: shrink-swell, low strength, frost action.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
MdB, MdC----------------- Mandeville	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones.
Nd----------------------- Nodaway	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
NoD---------------------- Norris	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
NoF---------------------- Norris	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope, area reclaim.
Pd*. Pits, quarries				
PoB, PoC2---------------- Polo	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
SaB, SaC, SaC3----------- Sampsel	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
ShB---------------------- Sharpsburg	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
SnD2--------------------- Snead	Poor: shrink-swell, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
SoD*:				
Snead--------------------	Poor: shrink-swell, large stones, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones, large stones.
Rock outcrop.				
SoF*:				
Snead--------------------	Poor: shrink-swell, large stones, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones, slope, large stones.
Rock outcrop.				
Wa----------------------- Wabash	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, too clayey.
WdB---------------------- Weller	Poor: shrink-swell, low strength, frost action.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
WfB, WfC-------------- Winfield	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
WfC3------------------ Winfield	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
Zk-------------------- Zook	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
BaB----------------- Barco	Depth to rock, seepage.	Thin layer------	Not needed------	Rooting depth	Depth to rock	Depth to rock.
BaC----------------- Barco	Slope, depth to rock, seepage.	Thin layer------	Not needed------	Rooting depth, slope.	Depth to rock	Depth to rock.
Bk------------------ Blackoar	Seepage---------	Wetness---------	Floods, frost action.	Wetness, floods.	Not needed------	Wetness.
BoC2---------------- Bolivar	Slope, seepage, depth to rock.	Thin layer------	Not needed------	Rooting depth, slope.	Depth to rock	Depth to rock.
BoD2---------------- Bolivar	Slope, seepage, depth to rock.	Thin layer------	Not needed------	Rooting depth, slope.	Depth to rock	Slope, depth to rock.
Br------------------ Bremer	Favorable-------	Compressible, unstable fill, shrink-swell.	Percs slowly----	Slow intake, wetness.	Not needed------	Not needed.
DpB----------------- Deepwater	Seepage---------	Favorable-------	Not needed------	Favorable-------	Erodes easily	Erodes easily.
DpC2---------------- Deepwater	Slope, seepage.	Favorable-------	Not needed------	Slope-----------	Erodes easily	Erodes easily.
Dt------------------ Dockery	Seepage---------	Compressible, low strength, piping.	Floods, wetness.	Floods, wetness.	Wetness---------	Wetness.
Fs------------------ Freeburg	Favorable-------	Hard to pack----	Frost action----	Wetness, erodes easily.	Not needed------	Erodes easily.
GoC2---------------- Gorin	Slope-----------	Wetness, hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily, wetness.	Erodes easily, percs slowly, wetness.	Erodes easily, percs slowly.
Hg------------------ Haig	Favorable-------	Compressible, low strength, shrink-swell.	Percs slowly----	Wetness---------	Not needed------	Wetness, percs slowly.
Hp*: Haplaquents.						
Urban land.						
HtA----------------- Hartwell	Favorable-------	Wetness---------	Percs slowly----	Wetness, erodes easily, percs slowly.	Not needed------	Wetness, erodes easily, percs slowly.
HtB2---------------- Hartwell	Favorable-------	Wetness---------	Percs slowly----	Wetness, erodes easily, percs slowly.	Percs slowly, wetness, erodes easily.	Wetness, erodes easily, percs slowly.
HxC----------------- Higginsville	Favorable-------	Wetness---------	Not needed------	Wetness, percs slowly, erodes easily.	Wetness, percs slowly.	Erodes easily, percs slowly, slope.
Ka------------------ Kanima	Seepage---------	Seepage, low strength.	Not needed------	Complex slope, droughty.	Not needed------	Not needed.
Lg------------------ Lightning	Favorable-------	Unstable fill, compressible.	Floods, percs slowly.	Floods, wetness.	Not needed------	Wetness.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
MaB: Macksburg	Favorable	Compressible, low strength, shrink-swell.	Favorable	Wetness	Favorable	Favorable.
MdB: Mandeville	Depth to rock, seepage.	Thin layer	Not needed	Rooting depth, erodes easily.	Depth to rock	Erodes easily, depth to rock.
MdC: Mandeville	Slope, seepage, depth to rock.	Thin layer	Not needed	Rooting depth, slope, erodes easily.	Depth to rock	Erodes easily, depth to rock.
Nd: Nodaway	Seepage	Favorable	Floods	Floods	Not needed	Favorable.
NoD: Norris	Slope, depth to rock.	Thin layer	Not needed	Rooting depth, slope.	Depth to rock	Slope, depth to rock, rooting depth.
NoF: Norris	Slope, depth to rock.	Thin layer	Not needed	Rooting depth, slope.	Slope, depth to rock.	Slope, depth to rock, rooting depth.
Pd*. Pits, quarries						
PoB: Polo	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
PoC2: Polo	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Favorable.
SaB: Sampsel	Depth to rock	Hard to pack	Percs slowly, frost action.	Percs slowly, wetness, erodes easily.	Percs slowly, wetness.	Erodes easily, percs slowly.
SaC, SaC3: Sampsel	Slope, depth to rock.	Hard to pack	Percs slowly, frost action, slope.	Percs slowly, wetness, erodes easily.	Percs slowly, wetness.	Erodes easily, percs slowly.
ShB: Sharpsburg	Favorable	Compressible, low strength, shrink-swell.	Not needed	Erodes easily	Favorable	Favorable.
SnD2: Snead	Slope, depth to rock.	Thin layer, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, rooting depth.	Depth to rock, wetness.	Slope, erodes easily, rooting depth.
SoD*: Snead	Slope, depth to rock.	Thin layer, wetness.	Percs slowly, depth to rock, slope.	Droughty, -large stones.	Depth to rock, large stones.	Droughty, slope, large stones.
Rock outcrop.						
SoF*: Snead	Slope, depth to rock.	Thin layer, wetness.	Percs slowly, depth to rock, slope.	Droughty, large stones.	Depth to rock, large stones, slope.	Droughty, slope, large stones.
Rock outcrop.						
Wa: Wabash	Favorable	Wetness, hard to pack.	Floods, percs slowly.	Slow intake, wetness, percs slowly.	Not needed	Percs slowly, wetness.
WdB: Weller	Favorable	Compressible, low strength, shrink-swell.	Not needed	Erodes easily, slow intake.	Percs slowly	Percs slowly, erodes easily.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
WfB----------------- Winfield	Seepage----------	Favorable-------	Not needed-----	Erodes easily	Favorable-------	Erodes easily.
WfC----------------- Winfield	Slope, seepage.	Favorable-------	Not needed-----	Erodes easily, slope.	Favorable-------	Erodes easily.
WfC3---------------- Winfield	Slope, seepage.	Favorable-------	Not needed-----	Erodes easily, slope.	Favorable-------	Slope, erodes easily.
Zk------------------ Zook	Favorable-------	Hard to pack, wetness.	Floods, percs slowly, frost action.	Floods, wetness, percs slowly.	Not needed-----	Wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
BaB Barco	Slight	Slight	Moderate: slope, depth to rock.	Slight.
BaC Barco	Slight	Slight	Severe: slope.	Slight.
Bk Blackoar	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
BoC2 Bolivar	Slight	Slight	Severe: slope.	Slight.
BoD2 Bolivar	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Br Bremer	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
DpB Deepwater	Slight	Slight	Moderate: slope.	Slight.
DpC2 Deepwater	Slight	Slight	Severe: slope.	Slight.
Dt Dockery	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: wetness, floods.	Moderate: wetness, floods.
Fs Freeburg	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.	Slight.
GoC2 Gorin	Moderate: wetness, percs slowly.	Moderate: wetness.	Severe: slope.	Slight.
Hg Haig	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, percs slowly.	Severe: wetness.
Hp*: Haplaquents.				
Urban land.				
HtA, HtB2 Hartwell	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.
HxC Higginsville	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, percs slowly, slope.	Slight.
Ka Kanima	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Lg Lightning	Severe: floods, percs slowly, wetness.	Moderate: floods, wetness.	Severe: percs slowly, wetness, floods.	Moderate: floods, wetness.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
MaB: Macksburg	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, slope.	Slight.
MdB: Mandeville	Slight	Slight	Moderate: slope, depth to rock.	Slight.
MdC: Mandeville	Slight	Slight	Severe: slope.	Slight.
Nd: Nodaway	Severe: floods.	Slight	Moderate: floods.	Slight.
NoD: Norris	Severe: depth to rock.	Moderate: slope.	Severe: slope, depth to rock.	Slight.
NoF: Norris	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, depth to rock.	Moderate: slope.
Pd*. Pits, quarries				
PoB: Polo	Slight	Slight	Moderate: slope.	Slight.
PoC2: Polo	Slight	Slight	Severe: slope.	Slight.
SaB: Sampsel	Moderate: wetness, percs slowly.	Moderate: too clayey.	Moderate: slope, too clayey, wetness.	Moderate: too clayey.
SaC, SaC3: Sampsel	Moderate: wetness, percs slowly.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
ShB: Sharpsburg	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
SnD2: Snead	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness, too clayey.	Severe: slope, depth to rock.	Moderate: too clayey.
SoD*: Snead	Severe: small stones.	Severe: small stones.	Severe: slope, small stones, depth to rock.	Severe: small stones.
Rock outcrop.				
SoF*: Snead	Severe: small stones, slope.	Severe: small stones, slope.	Severe: slope, small stones, depth to rock.	Severe: small stones.
Rock outcrop.				
Wa: Wabash	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey.	Severe: too clayey, wetness, percs slowly.	Severe: wetness, too clayey.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
WdB Weller	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: percs slowly, wetness, slope.	Slight.
WfB Winfield	Slight	Slight	Moderate: slope.	Slight.
WfC Winfield	Slight	Slight	Severe: slope.	Slight.
WfC3 Winfield	Moderate: slope, too clayey.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.
Zk Zook	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
BaB, BaC: Barco	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor.
Bk: Blackoar	Good	Good	Good	Fair	Fair	Good	Fair	Good	Fair	Fair.
BoC2, BoD2: Bolivar	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor.
Br: Bremer	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
DpB: Deepwater	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
DpC2: Deepwater	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor.
Dt: Dockery	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Fs: Freeburg	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
GoC2: Gorin	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor.
Hg: Haig	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Hp*:										
Haplaquents.										
Urban land.										
HtA: Hartwell	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
HtB2: Hartwell	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
HxC: Higginsville	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor.
Ka: Kanima	Very poor	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor.
Lg: Lightning	Fair	Good	Fair	Good	Good	Fair	Fair	Fair	Good	Fair.
MaB: Macksburg	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
MdB, MdC: Mandeville	Fair	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor.
Nd: Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
NoD, NoF: Norris	Poor	Fair	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Very poor.

See footnote at end of table.

TABLE 14.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Pd*. Pits, quarries										
PoB----------------- Polo	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor.
PoC2---------------- Polo	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor.
SaB, SaC, SaC3------ Sampsel	Fair	Good	Fair	Good	Good	Very poor	Very poor	Fair	Good	Very poor.
ShB----------------- Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
SnD2---------------- Snead	Fair	Good	Fair	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
SoD*: Snead--------------	Poor	Poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor.
Rock outcrop.										
SoF*: Snead--------------	Very poor	Very poor	Fair	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor.
Rock outcrop.										
Wa------------------ Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Fair.
WdB----------------- Weller	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
WfB----------------- Winfield	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor.
WfC, WfC3----------- Winfield	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor.
Zk------------------ Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
BaB, BaC----------- Barco	0-12	Loam-------------	ML, CL-ML	A-4	0	100	100	85-95	50-75	22-30	2-8
	12-38	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-5	85-100	85-100	80-98	45-80	25-40	11-22
	38-66	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bk----------------- Blackoar	0-65	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-18
BoC2--------------- Bolivar	0-11	Loam-------------	ML, CL-ML	A-4	0	100	90-100	70-95	55-75	20-30	NP-5
	11-29	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-10	85-100	85-100	70-95	45-80	25-40	10-25
	29-36	Weathered bedrock.	---	---	---	---	---	---	---	---	---
BoD2--------------- Bolivar	0-12	Fine sandy loam	ML, SM, SM-SC, CL-ML	A-4	0	100	90-100	70-95	40-55	20-30	NP-5
	12-24	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-10	85-100	85-100	70-95	45-80	25-40	10-25
	24-35	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Br----------------- Bremer	0-13	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-60	25-40
	13-50	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	100	95-100	50-65	20-35
	50-63	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-60	25-40
DpB, DpC2---------- Deepwater	0-10	Silt loam--------	CL	A-4, A-6, A-7	0	100	100	90-100	70-95	25-40	7-20
	10-75	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	85-95	35-50	15-26
Dt----------------- Dockery	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	10-20
	9-90	Stratified silt loam, silty clay loam.	CL-ML, CL	A-6, A-7, A-4	0	100	100	90-100	70-95	25-45	5-20
Fs----------------- Freeburg	0-17	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	90-100	15-35	5-15
	17-82	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	85-100	85-100	30-45	15-25
GoC2--------------- Gorin	0-5	Silt loam--------	CL, ML	A-4, A-6	0	100	100	90-100	85-100	30-40	5-15
	5-15	Silty clay-------	CH	A-7	0	100	100	95-100	92-100	50-65	32-39
	15-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	90-100	80-95	70-90	30-50	12-30
Hg----------------- Haig	0-7	Silt loam--------	CL, OL	A-6, A-7	0	100	100	95-100	90-100	35-45	10-20
	7-13	Silty clay loam	CL, CH	A-7	0	100	100	95-100	90-100	40-55	20-30
	13-38	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	50-65	30-40
	38-64	Silty clay loam	CL, CH	A-7, A-6	0	100	100	95-100	90-100	35-55	20-30
Hp*: Haplaquents.											
Urban land.											

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
HtA-----------------Hartwell	0-12	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	20-35	5-15
	12-33	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-65	30-40
	33-78	Silt loam, silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	20-25
HtB2----------------Hartwell	0-7	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	20-35	5-15
	7-30	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	50-65	30-40
	30-60	Silt loam, silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	20-25
HxC-----------------Higginsville	0-8	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	95-100	25-35	8-15
	8-29	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-22
	29-69	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	20-25
Ka------------------Kanima	0-7	Shaly silty clay loam.	ML, CL, SM, SC	A-2, A-4, A-6	0-7	10-80	5-75	5-70	5-70	15-35	1-14
	7-60	Very shaly clay loam, very shaly silt loam, very shaly silty clay loam.	ML, CL, SM, SC	A-2, A-4, A-6	7-40	10-60	5-55	5-55	5-55	15-35	1-14
Lg------------------Lightning	0-8	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	85-98	30-40	8-19
	8-78	Silty clay loam, silty clay, clay.	CL, CH, MH	A-6, A-7	0	100	100	96-100	90-99	37-70	15-40
MaB-----------------Macksburg	0-8	Silt loam--------	ML, OL, CL, CH	A-7	0	100	100	100	95-100	41-55	15-25
	8-38	Silty clay loam, silty clay.	CH	A-7	0	100	100	100	95-100	50-60	25-35
	38-94	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
MdB, MdC------------Mandeville	0-6	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	90-100	75-95	20-30	NP-10
	6-29	Silt loam, shaly loam, silty clay loam.	CL	A-6, A-4	0-5	60-95	60-90	55-90	50-90	28-40	8-20
	29-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Nd------------------Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
NoD, NoF------------Norris	0-16	Shaly silt loam	ML, CL, SM, SC	A-4	0-2	75-95	65-90	60-85	40-55	15-25	2-8
	16-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Pd*. Pits, quarries											
PoB, PoC2-----------Polo	0-9	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
	9-75	Silty clay, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
SaB, SaC------------Sampsel	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-99	35-50	15-25
	17-88	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	97-100	95-100	52-75	35-45
SaC3----------------Sampsel	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-99	35-50	15-25
	7-91	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	97-100	95-100	52-75	35-45

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
ShB----------------	0-10	Silt loam--------	CL	A-6	0	100	100	100	95-100	25-40	10-20
Sharpsburg	10-53	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-60	20-35
	53-85	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
SnD2----------------	0-8	Silty clay loam	CL	A-6, A-7	0-10	90-100	90-100	90-100	80-95	35-50	15-25
Snead	8-23	Silty clay, clay	CH	A-7	0-10	90-100	90-100	90-100	80-100	52-70	35-45
	23-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---
SoD*, SoF*:											
Snead--------------	0-5	Silty clay loam	CL	A-6, A-7	0-10	90-100	90-100	90-100	80-95	35-50	15-25
	5-24	Silty clay, clay	CH	A-7	0-10	90-100	90-100	90-100	80-100	52-70	35-45
	24-40	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Wa-----------------	0-15	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-55
Wabash	15-66	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
WdB----------------	0-12	Silt loam--------	ML, CL	A-6, A-4	0	100	100	100	95-100	30-40	5-15
Weller	12-34	Silty clay loam, silty clay.	CH	A-7	0	100	100	100	95-100	50-65	30-40
	34-76	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-55	20-30
WfB, WfC-----------	0-8	Silt loam--------	CL	A-6	0	100	100	95-100	92-100	25-40	10-20
Winfield	8-78	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	95-100	35-45	20-25
WfC3---------------	0-6	Silty clay loam	CL	A-6	0	100	100	95-100	92-100	25-40	10-20
Winfield	6-60	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	95-100	35-45	20-25
Zk-----------------	0-22	Silty clay loam	MH, CH, CL, OL	A-7	0	100	100	95-100	95-100	45-70	20-40
Zook	22-90	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	40-60

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than. Entries under "Erosion factors--(T)" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
BaB, BaC: Barco	0-12	2.0-6.0	0.16-0.21	4.5-6.5	Low	0.28	4	5
	12-38	0.6-2.0	0.12-0.16	4.5-6.5	Moderate	0.28		
	38-66	---	---	---	---	---		
Bk: Blackoar	0-65	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.28	5	6
BoC2: Bolivar	0-11	0.6-2.0	0.19-0.21	5.1-6.5	Low	0.32	4	5
	11-29	0.6-2.0	0.12-0.16	4.5-6.0	Moderate	0.32		
	29-36	---	---	---	---	---		
BoD2: Bolivar	0-12	2.0-6.0	0.16-0.18	5.1-6.5	Low	0.32	4	3
	12-24	0.6-2.0	0.12-0.16	4.5-6.0	Moderate	0.32		
	24-35	---	---	---	---	---		
Br: Bremer	0-13	0.2-0.6	0.21-0.23	5.6-6.5	Moderate	---	---	7
	13-50	0.06-0.2	0.15-0.17	6.1-6.5	High	---		
	50-63	0.2-0.6	0.18-0.20	6.1-6.5	High	---		
DpB, DpC2: Deepwater	0-10	0.6-2.0	0.21-0.24	5.6-7.3	Low	0.32	5-4	7
	10-75	0.6-2.0	0.18-0.20	5.1-7.3	Moderate	0.43		
Dt: Dockery	0-9	0.2-2.0	0.20-0.24	6.1-7.3	Moderate	0.37	5	6
	9-90	0.2-2.0	0.20-0.24	6.1-7.3	Moderate	0.37	---	
Fs: Freeburg	0-17	0.6-2.0	0.22-0.24	5.1-7.3	Low	0.37	5	6
	17-82	0.2-0.6	0.16-0.20	4.5-6.0	Moderate	0.37		
GoC2: Gorin	0-5	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.43	3	6
	5-15	0.06-0.2	0.11-0.13	5.1-6.5	High	0.32		
	15-60	0.2-0.6	0.18-0.20	5.6-7.3	Moderate	0.32		
Hg: Haig	0-7	0.6-2.0	0.22-0.24	5.6-6.5	Moderate	0.32	3	6
	7-13	0.6-2.0	0.21-0.23	5.1-6.5	High	0.32		
	13-38	<0.2	0.12-0.14	5.1-6.0	High	0.32		
	38-64	0.2-0.6	0.18-0.20	6.1-7.3	High	0.32		
Hp*: Haplaquents.								
Urban land.								
HtA: Hartwell	0-12	0.2-0.6	0.22-0.24	5.1-6.5	Low	0.43	3	6
	12-33	0.06-0.2	0.09-0.13	5.1-6.5	High	0.32		
	33-78	0.06-0.2	0.18-0.20	5.1-7.3	Moderate	0.43		
HtB2: Hartwell	0-7	0.2-0.6	0.22-0.24	5.1-6.5	Low	0.43	3	6
	7-30	0.06-0.2	0.09-0.13	5.1-6.5	High	0.32		
	30-60	0.06-0.2	0.18-0.20	5.1-7.3	Moderate	0.43		
HxC: Higginsville	0-8	0.6-2.0	0.21-0.24	5.6-7.3	Low	0.37	4-3	6
	8-29	0.2-0.6	0.15-0.19	5.1-6.5	Moderate	0.37		
	29-69	0.06-0.2	0.14-0.19	5.1-6.5	Moderate	0.37		
Ka: Kanima	0-7	0.6-6.0	0.02-0.15	4.5-8.4	Low	0.28	4	---
	7-60	0.6-6.0	0.02-0.12	4.5-8.4	Low	0.28		
Lg: Lightning	0-8	0.06-0.6	0.16-0.20	4.5-7.3	Moderate	0.49	5	---
	8-78	<0.06	0.12-0.20	4.5-8.4	High	0.37		

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permea- bility	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
MaB-------------- Macksburg	0-8	0.6-2.0	0.21-0.23	5.1-6.5	Moderate------	0.32	5	6
	8-38	0.2-0.6	0.18-0.20	5.1-6.5	High----------	0.43		
	38-94	0.2-0.6	0.18-0.20	5.6-6.5	High----------	0.43		
MdB, MdC--------- Mandeville	0-6	0.6-2.0	0.22-0.24	5.1-6.5	Low-----------	0.37	4	6
	6-29	0.6-2.0	0.17-0.22	4.5-6.0	Low-----------	0.37		
	29-60	---	---	---	--------------	---		
Nd--------------- Nodaway	0-60	0.6-2.0	0.20-0.23	6.1-7.3	Moderate------	0.37	5	7
NoD, NoF--------- Norris	0-16	0.6-2.0	0.08-0.18	4.5-5.5	Low-----------	0.32	2	5
	16-60	---	---	---	--------------	---		
Pd*. Pits, quarries								
PoB, PoC2-------- Polo	0-9	0.6-2.0	0.22-0.24	5.6-6.5	Low-----------	0.32	5	6
	9-75	0.6-2.0	0.12-0.18	4.5-6.5	Moderate------	0.32		
SaB, SaC--------- Sampsel	0-17	0.2-0.6	0.21-0.24	5.6-7.3	Moderate------	0.37	3-2	4
	17-88	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.37		
SaC3------------- Sampsel	0-7	0.2-0.6	0.21-0.24	5.6-7.3	Moderate------	0.37	3-2	4
	7-91	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.37		
ShB-------------- Sharpsburg	0-10	0.6-2.0	0.21-0.23	5.1-6.5	Moderate------	0.32	5-4	6
	10-53	0.2-0.6	0.18-0.20	5.1-6.0	High----------	0.43		
	53-85	0.2-0.6	0.18-0.20	5.6-6.5	Moderate------	0.43		
SnD2------------- Snead	0-8	0.2-0.6	0.21-0.23	6.1-7.3	Moderate------	0.37	3	6
	8-23	0.06-0.2	0.09-0.13	6.6-8.4	High----------	0.37		
	23-60	---	---	---	--------------	---		
SoD*, SoF*:								
Snead------------	0-5	0.2-0.6	0.21-0.23	6.1-7.3	Moderate------	0.37	3	6
	5-24	0.06-0.2	0.09-0.13	6.6-8.4	High----------	0.37		
	24-40	---	---	---	--------------	---		
Rock outcrop.								
Wa--------------- Wabash	0-15	<0.06	0.12-0.14	5.6-7.8	Very high-----	0.28	5	4
	15-66	<0.06	0.08-0.12	5.6-7.8	Very high-----	0.28		
WdB-------------- Weller	0-12	0.6-2.0	0.22-0.24	6.1-7.4	Low-----------	0.43	3	6
	12-34	0.06-0.2	0.12-0.18	4.5-6.5	High----------	0.43		
	34-76	0.2-0.6	0.18-0.20	5.1-7.4	High----------	0.43		
WfB, WfC--------- Winfield	0-8	0.6-2.0	0.22-0.24	5.6-7.3	Low-----------	0.37	5	6
	8-78	0.6-2.0	0.18-0.20	4.5-6.5	Moderate------	0.37		
WfC3------------- Winfield	0-6	0.6-2.0	0.18-0.20	5.6-7.3	Moderate------	0.37	4	7
	6-60	0.6-2.0	0.18-0.20	4.5-6.0	Moderate------	0.37		
Zk--------------- Zook	0-22	0.2-0.6	0.21-0.23	5.6-7.8	High----------	0.28	5	7
	22-90	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

[The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
BaB, BaC----------- Barco	B	None---------	---	---	>6.0	---	---	20-40	Rippable	---	Low-------	Moderate.
Bk----------------- Blackoar	B/D	Occasional	Brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
BoC2, BoD2--------- Bolivar	B	None---------	---	---	>6.0	---	---	20-40	Rippable	---	Low-------	Moderate.
Br----------------- Bremer	C	Rare---------	---	---	1.0-3.0	Apparent	Nov-Mar	>60	---	High-----	Moderate	Moderate.
DpB, DpC2---------- Deepwater	B	None---------	---	---	3.0-6.0	Perched	Nov-Mar	>60	---	---	High-----	Moderate.
Dt----------------- Dockery	C	Frequent----	Brief-----	Nov-Jun	1.0-3.0	Apparent	Nov-Apr	>60	---	High-----	Moderate	Low.
Fs----------------- Freeburg	C	Rare---------	---	---	1.5-3.0	Perched	Nov-May	>60	---	High-----	Moderate	High.
GoC2--------------- Gorin	C	None---------	---	---	2.0-4.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
Hg----------------- Haig	C/D	None---------	---	---	0-3.0	Perched	Apr-Jul	>60	---	High-----	High-----	Moderate.
Hp*: Haplaquents.												
Urban land.												
HtA, HtB2---------- Hartwell	D	None---------	---	---	0.5-1.5	Perched	Nov-Apr	>60	---	---	High-----	Moderate.
HxC---------------- Higginsville	C	None---------	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	High-----	Moderate	Moderate.
Ka----------------- Kanima	C	None---------	---	---	>6.0	---	---	>60	---	---	Moderate	Low.
Lg----------------- Lightning	D	Occasional---	Very brief	Jan-Jul	0-2.0	Perched	Nov-Apr	>60	---	---	High-----	Moderate.
MaB---------------- Macksburg	B	None---------	---	---	2.0-4.0	Perched	Apr-Jul	>60	---	High-----	High-----	Moderate.
MdB, MdC----------- Mandeville	B	None---------	---	---	>6.0	---	---	20-40	Rippable	Moderate	Low-------	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Nd---------------- Nodaway	B	Common------	Brief-----	Feb-Nov	>6.0	---	---	>60	---	High-----	Moderate	Low.
NoD, NoF---------- Norris	D	None--------	---	---	>6.0	---	---	8-20	Rippable	Moderate	Low------	High.
Pd*. Pits, quarries												
PoB, PoC2--------- Polo	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
SaB, SaC, SaC3---- Sampsel	D	None--------	---	---	1.5-3.0	Perched	Nov-Apr	40-70	Rippable	High-----	High-----	Low.
ShB--------------- Sharpsburg	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
SnD2-------------- Snead	D	None--------	---	---	2.0-3.0	Perched	Nov-Mar	15-30	Rippable	Moderate	High-----	Low.
SoD*, SoF*: Snead------------	D	None--------	---	---	2.0-3.0	Perched	Nov-Mar	15-30	Rippable	Moderate	High-----	Low.
Rock outcrop.												
Wa---------------- Wabash	D	Frequent----	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	Moderate	High-----	Moderate.
WdB--------------- Weller	C	None--------	---	---	2.0-4.0	Perched	Apr-Jul	>60	---	High-----	High-----	High.
WfB, WfC, WfC3---- Winfield	B	None--------	---	---	3.0-4.0	Perched	Nov-Apr	>60	---	High-----	Moderate	Moderate.
Zk---------------- Zook	C/D	Frequent----	Brief-----	Mar-Jun	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--ENGINEERING INDEX TEST DATA

[Dashes indicate that data were not available]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Maximum density	Optimum moisture
											Pct		Lb/ft3	Pct
Deepwater silt loam: (S75MO-101-004)														
Ap------ 0 to 13	A-6 (12)	CL	100	100	100	98	94	--	--	--	34	12	102	18
B21----- 16 to 53	A-7-6(24)	CL	100	99	98	94	90	--	--	--	47	25	100	21
Hartwell silt loam: (S75MO-101-002)														
Ap------ 0 to 12	A-4 (06)	ML	100	100	100	98	96	--	--	--	32	5	100	20
B22t---- 12 to 33	A-7-5(46)	CH	100	100	100	99	98	--	--	--	69	39	89	27
B3t----- 33 to 54	A-7-6(35)	CH	100	100	100	98	95	--	--	--	55	33	99	23
Mandeville silt loam: (S75MO-101-003)														
Ao------ 0 to 6	A-4 (02)	ML	100	100	100	95	84	--	--	--	29	2	102	18
B1------ 6 to 29	A-7-6(22)	CL	100	100	100	96	90	--	--	--	49	22	102	21
C------- 29 to 40	A-7-6(17)	CL	100	100	100	97	90	--	--	--	41	18	107	17
Sampsel silty clay loam: (S75MO-101-001)														
Ap------ 0 to 20	A-7-6(24)	CL	100	100	100	99	95	--	--	--	49	22	95	23
B21t---- 20 to 56	A-7-6(39)	CH	100	100	100	98	94	--	--	--	61	37	95	24

TABLE 19.--CLASSIFICATION OF THE SOILS

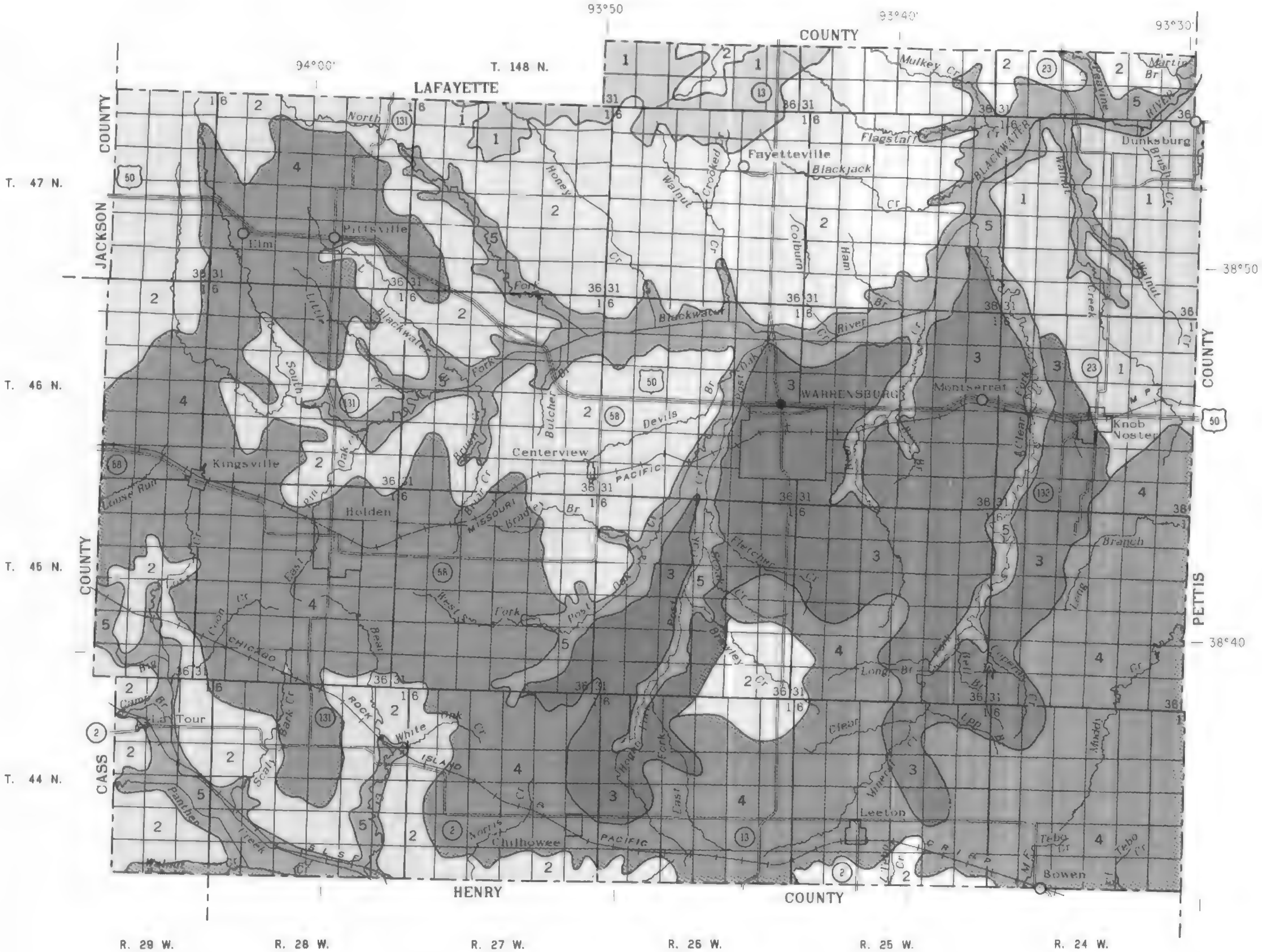
Soil name	Family or higher taxonomic class
Barco	Fine-loamy, mixed, thermic Mollic Hapludalfs
Blackoar	Fine-silty, mixed, mesic Fluvaquentic Haplaquolls
Bolivar	Fine-loamy, mixed, thermic Ultic Hapludalfs
Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
Deepwater	Fine-silty, mixed, thermic Typic Argiudolls
Dockery	Fine-silty, mixed, nonacid, mesic Aquic Udifluvents
Freeburg	Fine-silty, mixed, mesic Aquic Hapludalfs
Gorin	Fine, montmorillonitic, mesic Aquic Hapludalfs
Haig	Fine, montmorillonitic, mesic Typic Argiaquolls
Haplaquents	Fine, montmorillonitic, mesic Typic Haplaquents
Hartwell	Fine, mixed, thermic Typic Argialbolls
Higginsville	Fine-silty, mixed, mesic Aquic Argiudolls
Kanima	Loamy-skeletal, mixed, nonacid, thermic Udalfic Arents
Lightning	Fine, mixed, thermic Typic Ochraqualfs
Macksburg	Fine, montmorillonitic, mesic Aquic Argiudolls
Mandeville	Fine-loamy, mixed, mesic Typic Hapludalfs
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Norris	Loamy, mixed, acid, mesic, shallow Typic Udorthents
Polo	Fine, montmorillonitic, mesic Typic Argiudolls
Sampsel	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Snead	Fine, mixed, mesic Aquic Hapludolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Weller	Fine, montmorillonitic, mesic Aquic Hapludalfs
Winfield	Fine-silty, mixed, mesic Typic Hapludalfs
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

☆ U S GOVERNMENT PRINTING OFFICE: 1980-299-337/76

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.



Index Map

Welcome Page

Manuscript

N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISSOURI AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

JOHNSON COUNTY, MISSOURI

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

SOIL LEGEND

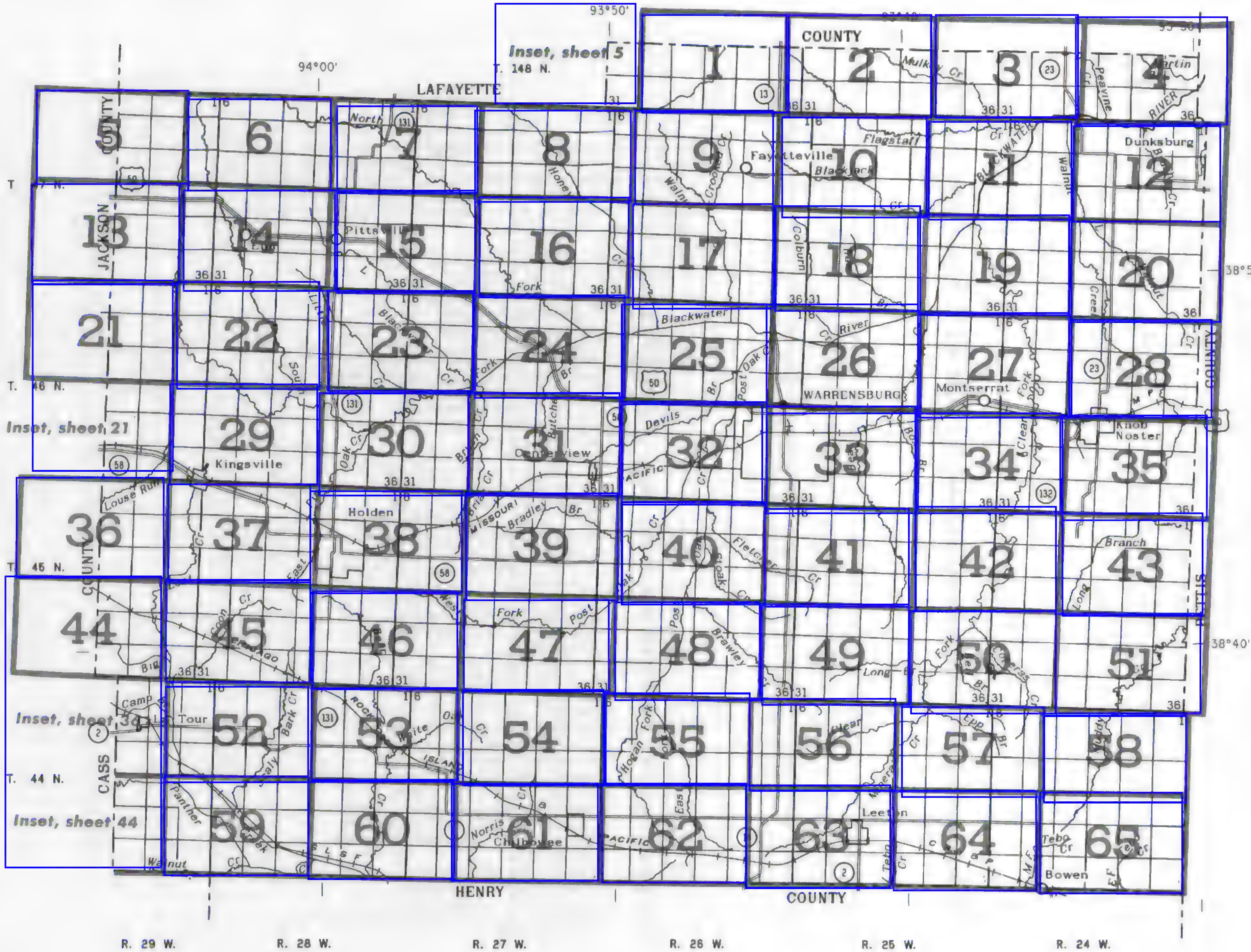
1	Macksburg–Sampsel association: Deep, gently sloping and moderately sloping, somewhat poorly drained soils that formed in loess and residuum from shale; on uplands
2	Sampsel–Snead–Polo association: Deep and moderately deep, gently sloping to steep, well drained to somewhat poorly drained soils that formed in loess and residuum from limestone and shale; on uplands
3	Mandeville–Norris–Bolivar association: Shallow and moderately deep, gently sloping to steep, well drained and moderately well drained soils that formed in residuum from sandstone and shale; on uplands
4	Sampsel–Deepwater–Haig association: Deep, nearly level to moderately sloping, moderately well drained to poorly drained soils that formed mostly in loess and residuum from shale; on uplands
5	Zook–Dockery–Blackoar association: Deep, nearly level, somewhat poorly drained and poorly drained soils that formed in alluvium; on bottom land

Compiled 1979

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



INDEX TO MAP SHEETS

JOHNSON COUNTY, MISSOURI

Scale 1: 253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

General Soil Map

Welcome Page

Manuscript

legend

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

SOIL LEGEND

Map symbols consist of a combination of letters or of letters and numbers. The first capital letter is the initial one of the map unit name. The lowercase letter that follows separates map units having names that begin with the same letter, except that it does not separate sloping or eroded phases. The second capital letter indicates the class of slope. Symbols without a slope letter are generally for nearly level soils or miscellaneous areas. A final number of 2 indicates that the soil is eroded and 3 that it is severely eroded.

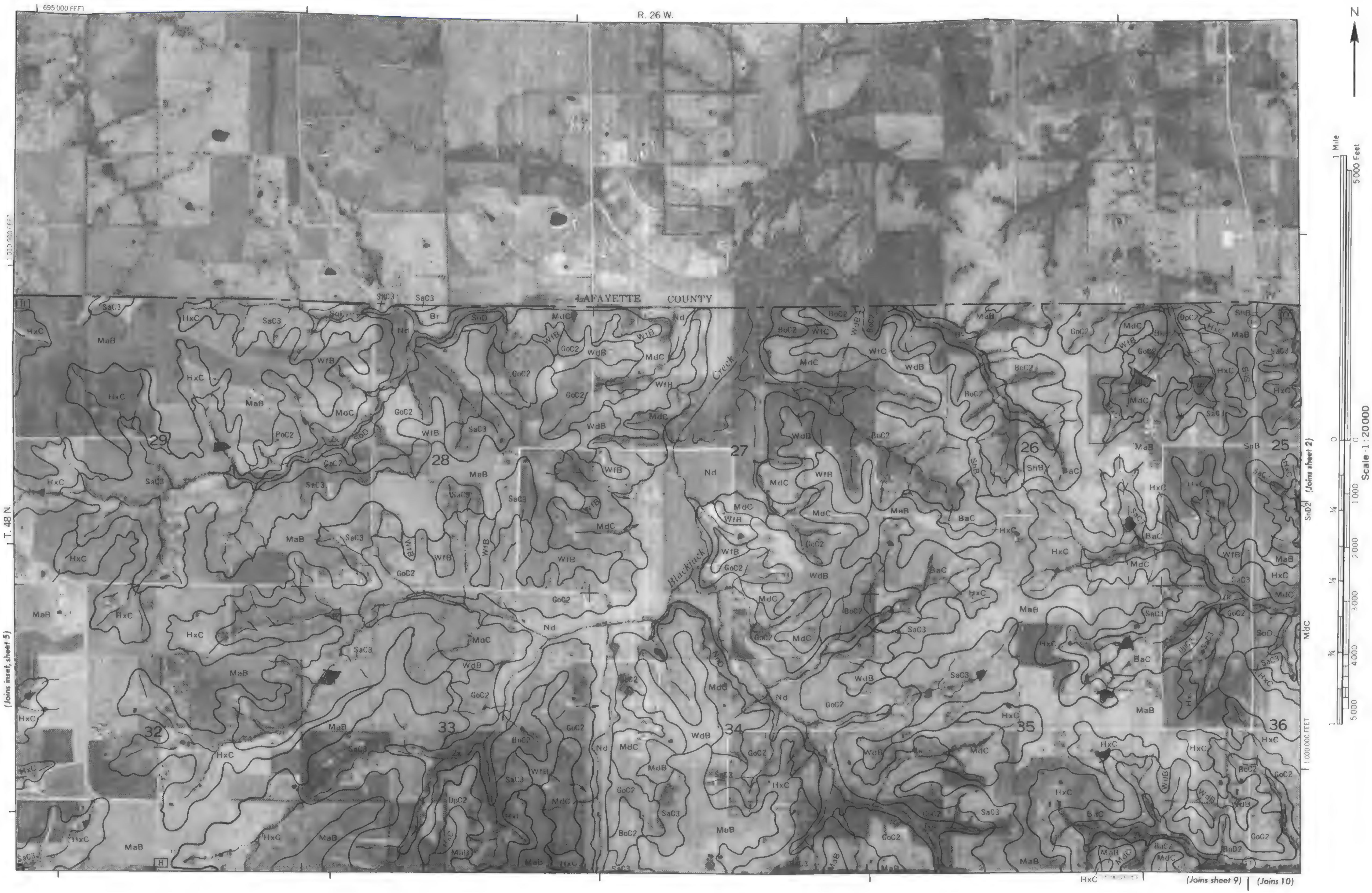
SYMBOL	NAME
BaB	Barco loam, 2 to 5 percent slopes
BaC	Barco loam, 5 to 9 percent slopes
Bk	Blackoar silt loam
BoC2	Bolivar loam, 5 to 9 percent slopes, eroded
BoD2	Bolivar fine sandy loam, 9 to 14 percent slopes, eroded
Br	Bremer silty clay loam
DpB	Deepwater silt loam, 2 to 5 percent slopes
DpC2	Deepwater silt loam, 5 to 9 percent slopes, eroded
Dt	Dockery silty clay loam
Fs	Freeburg silt loam
GoC2	Gorin silt loam, 5 to 9 percent slopes, eroded
Hg	Haig silt loam
Hp	Haplaquents–Urban land complex
HtA	Hartwell silt loam, 0 to 2 percent slopes
HtB2	Hartwell silt loam, 2 to 5 percent slopes, eroded
HxC	Higginsville silt loam, 4 to 7 percent slopes
Ka	Kanima shaly silty clay loam, 30 to 60 percent slopes
Lg	Lightning silt loam
MaB	Macksburg silt loam, 1 to 4 percent slopes
MdB	Mandeville silt loam, 2 to 5 percent slopes
MdC	Mandeville silt loam, 5 to 9 percent slopes
Nd	Nodaway silt loam
NoD	Norris shaly silt loam, 5 to 14 percent slopes
NoF	Norris shaly silt loam, 14 to 35 percent slopes
Pd	Pits, quarries
PoB	Polo silt loam, 2 to 5 percent slopes
PoC2	Polo silt loam, 5 to 9 percent slopes, eroded
SaB	Sampsel silty clay loam, 2 to 5 percent slopes
SaC	Sampsel silty clay loam, 5 to 9 percent slopes
SaC3	Sampsel silty clay loam, 5 to 9 percent slopes, severely eroded
ShB	Sharpsburg silt loam, 2 to 5 percent slopes
SnD2	Snead silty clay loam, 7 to 16 percent slopes, eroded
SoD	Snead–Rock outcrop complex, 5 to 14 percent slopes
SoF	Snead–Rock outcrop complex, 14 to 35 percent slopes
Wa	Wabash silty clay
WdB	Weller silt loam, 2 to 5 percent slopes
WfB	Winfield silt loam, 2 to 5 percent slopes
WfC	Winfield silt loam, 5 to 9 percent slopes
WfC3	Winfield silty clay loam, 5 to 9 percent slopes, severely eroded
Zk	Zook silty clay loam

Index Map

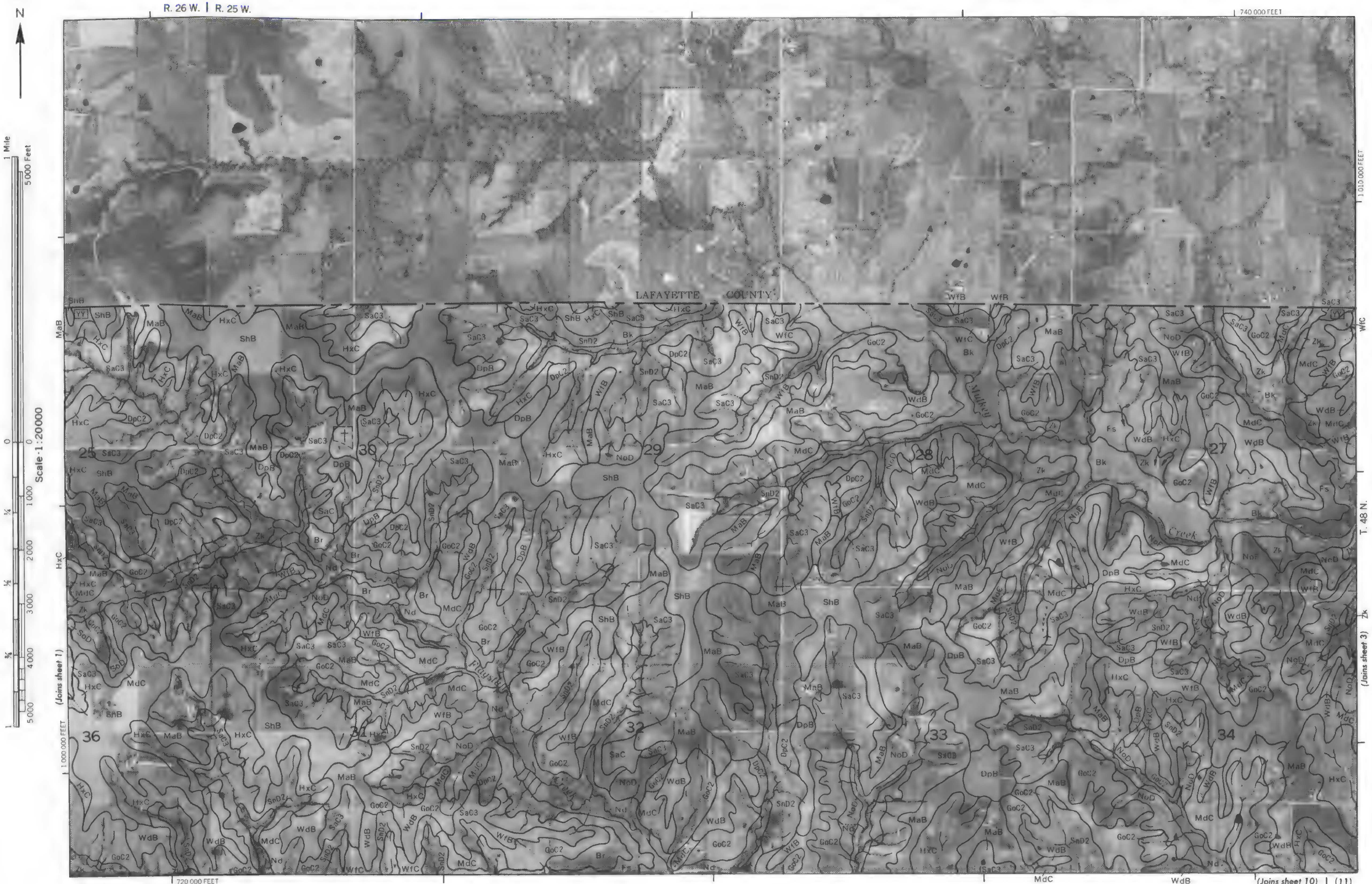
Welcome Page

Manuscript

Index Map Welcome Page Manuscript JOHNSON COUNTY, MISSOURI — SHEET NUMBER 1

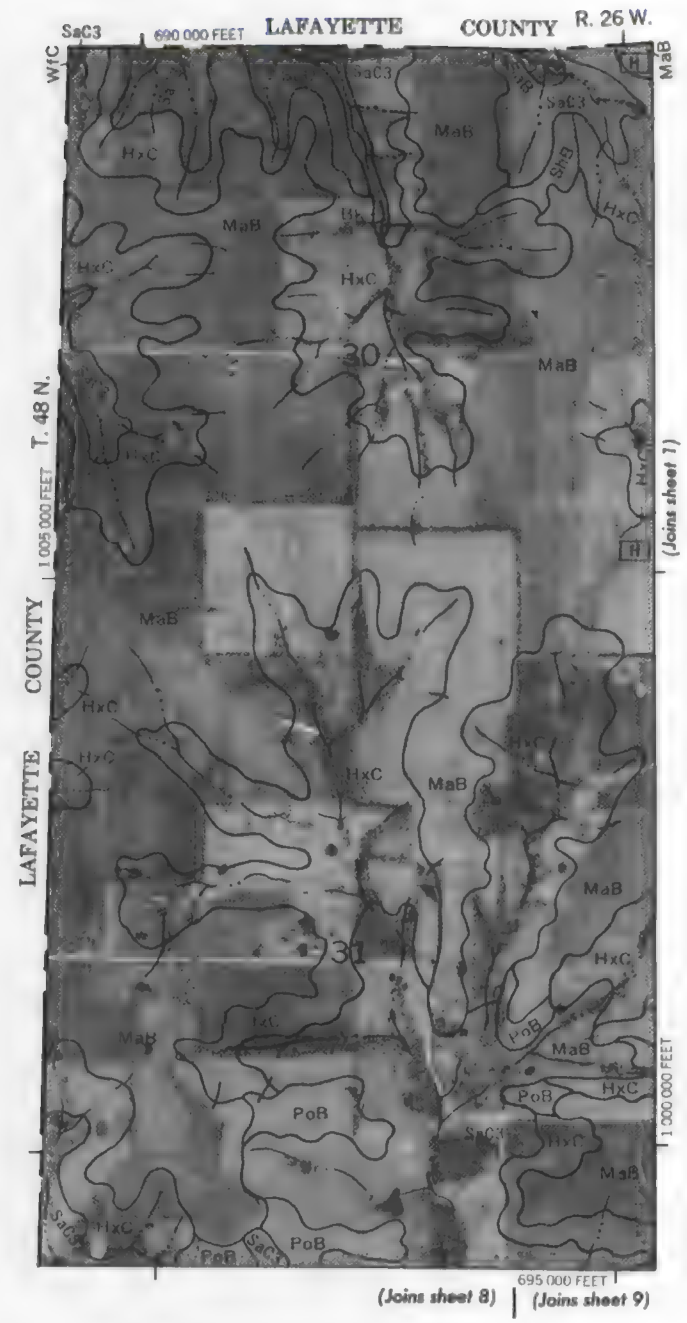


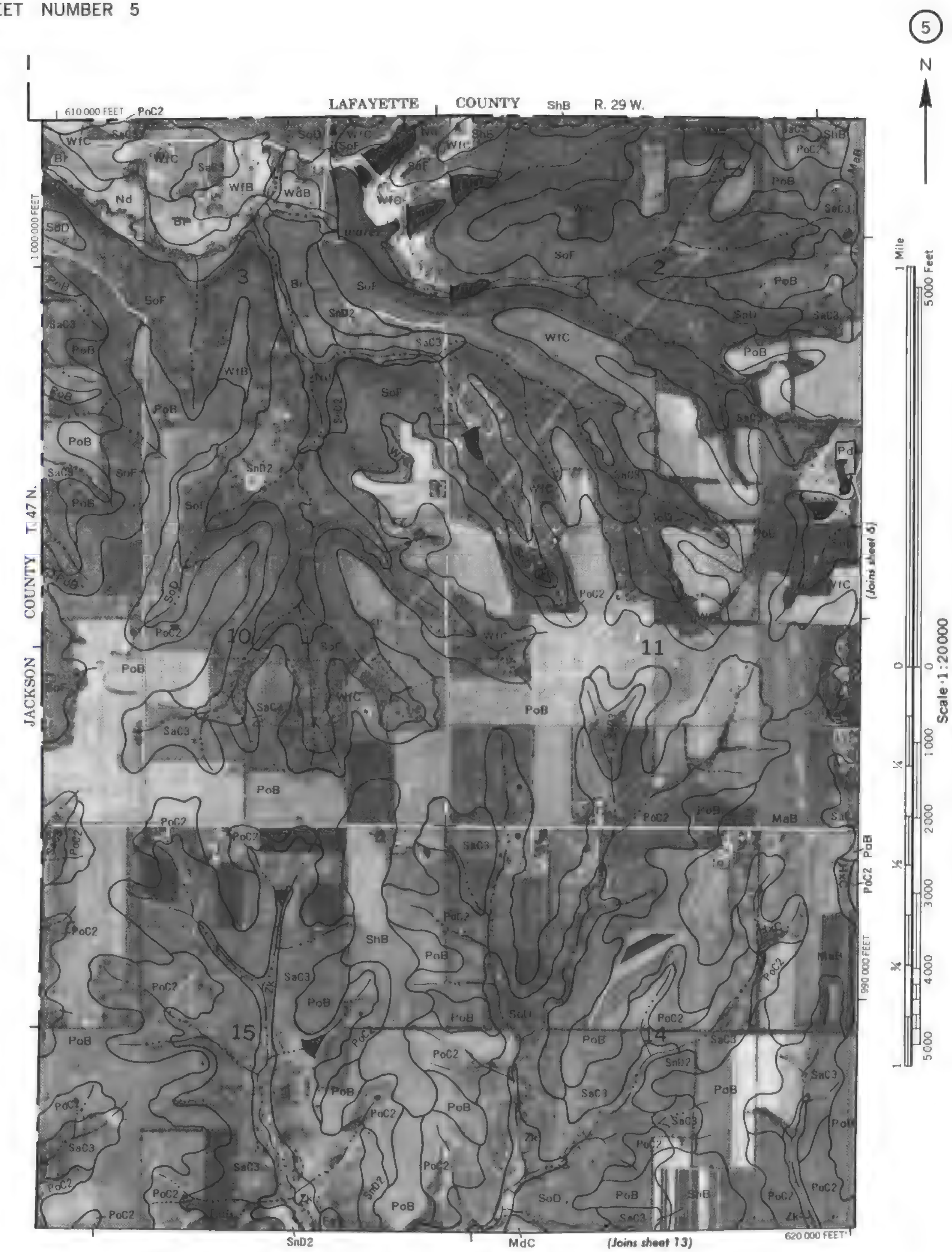
JOHNSON COUNTY, MISSOURI — SHEET NUMBER 2

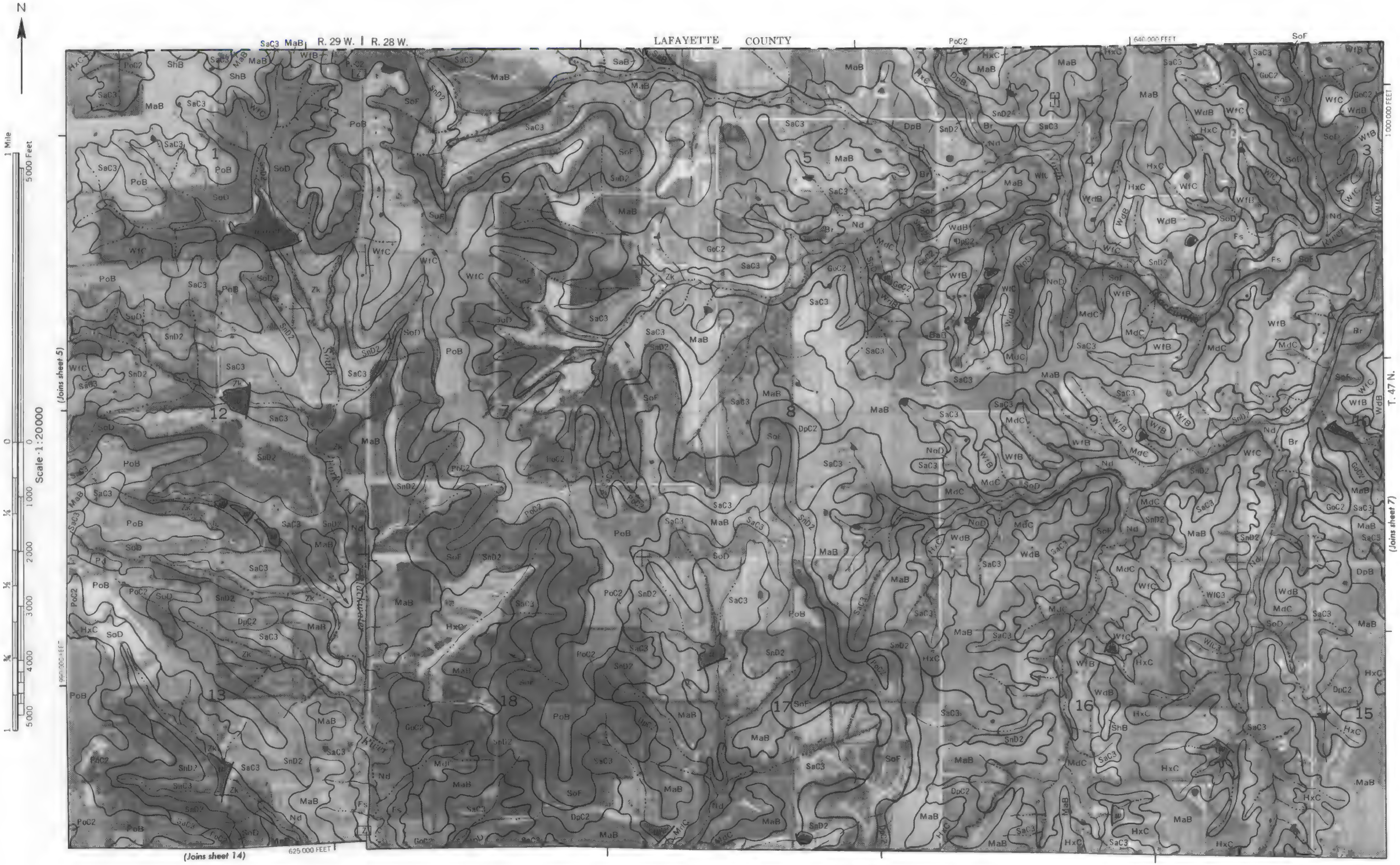



3
N
745 000 FEET
R. 25 W. | R. 24 W.
1 010 000 FEET
LAFAYETTE COUNTY
Ernestville
T. 48 N.
Mulkey
Creek
Peavine
Creek
Blackwater
River
26
25
30
29
28
35
36
31
32
33
(Joins sheet 2)
(Joins sheet 4)
1 000 000 FEET
765 000 FEET
(Joins sheet 11)
(sh 12)
1 Mile
5000 Feet
Scale 1:20000

JOHNSON COUNTY, MISSOURI — SHEET NUMBER 4

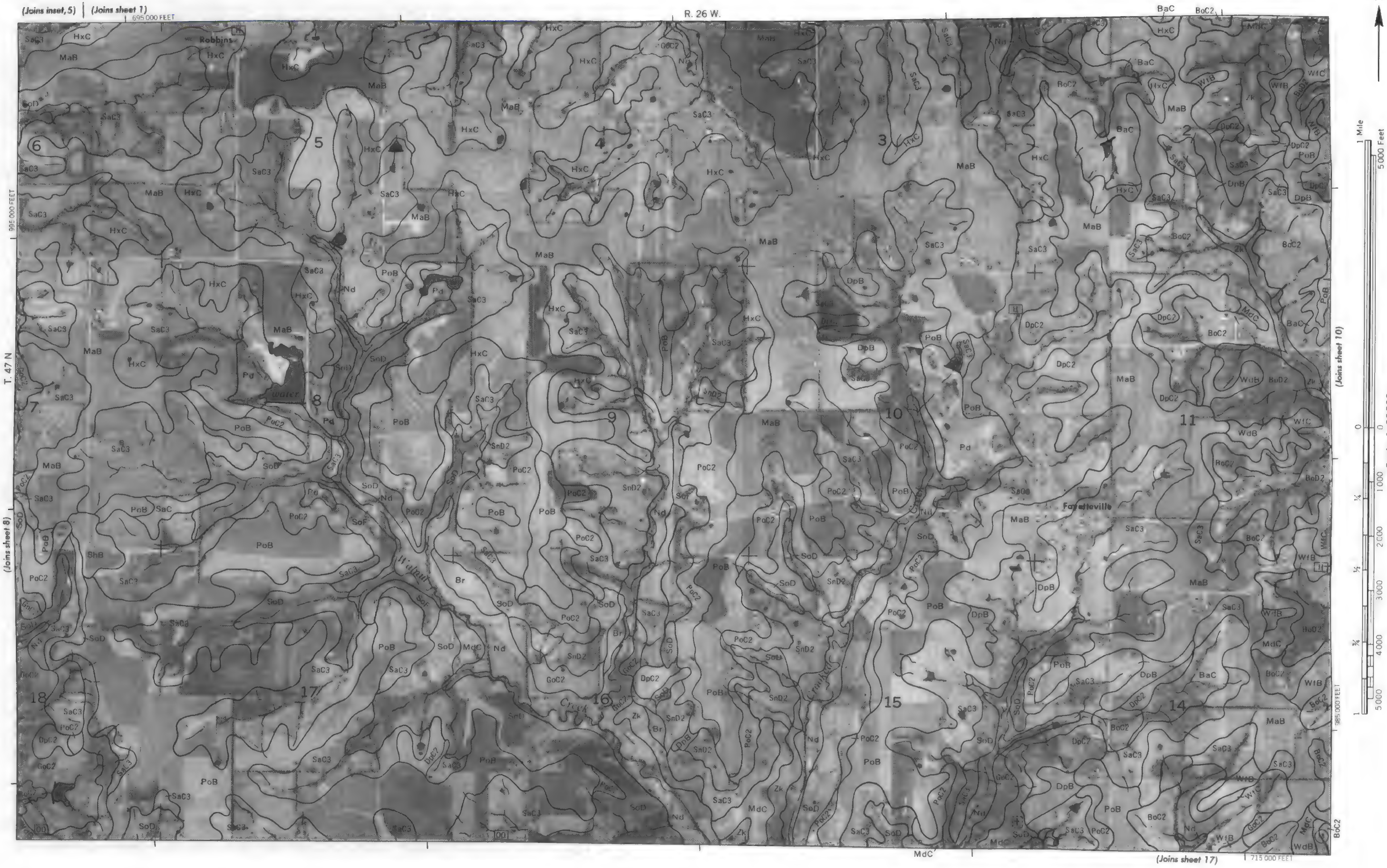

LAFAYETTE COUNTY R. 26 W.
690 000 FEET
T. 48 N.
LAFAYETTE COUNTY
1 005 000 FEET
1 000 000 FEET
695 000 FEET
(Joins sheet 1)
(Joins sheet 8)
(Joins sheet 9)
30
31


5
N
LAFAYETTE COUNTY R. 29 W.
610 000 FEET
1 000 000 FEET
T. 47 N.
JACKSON COUNTY
990 000 FEET
620 000 FEET
(Joins sheet 6)
(Joins sheet 13)
1 Mile
5000 Feet
Scale 1:20000
3
2
10
11
15
14

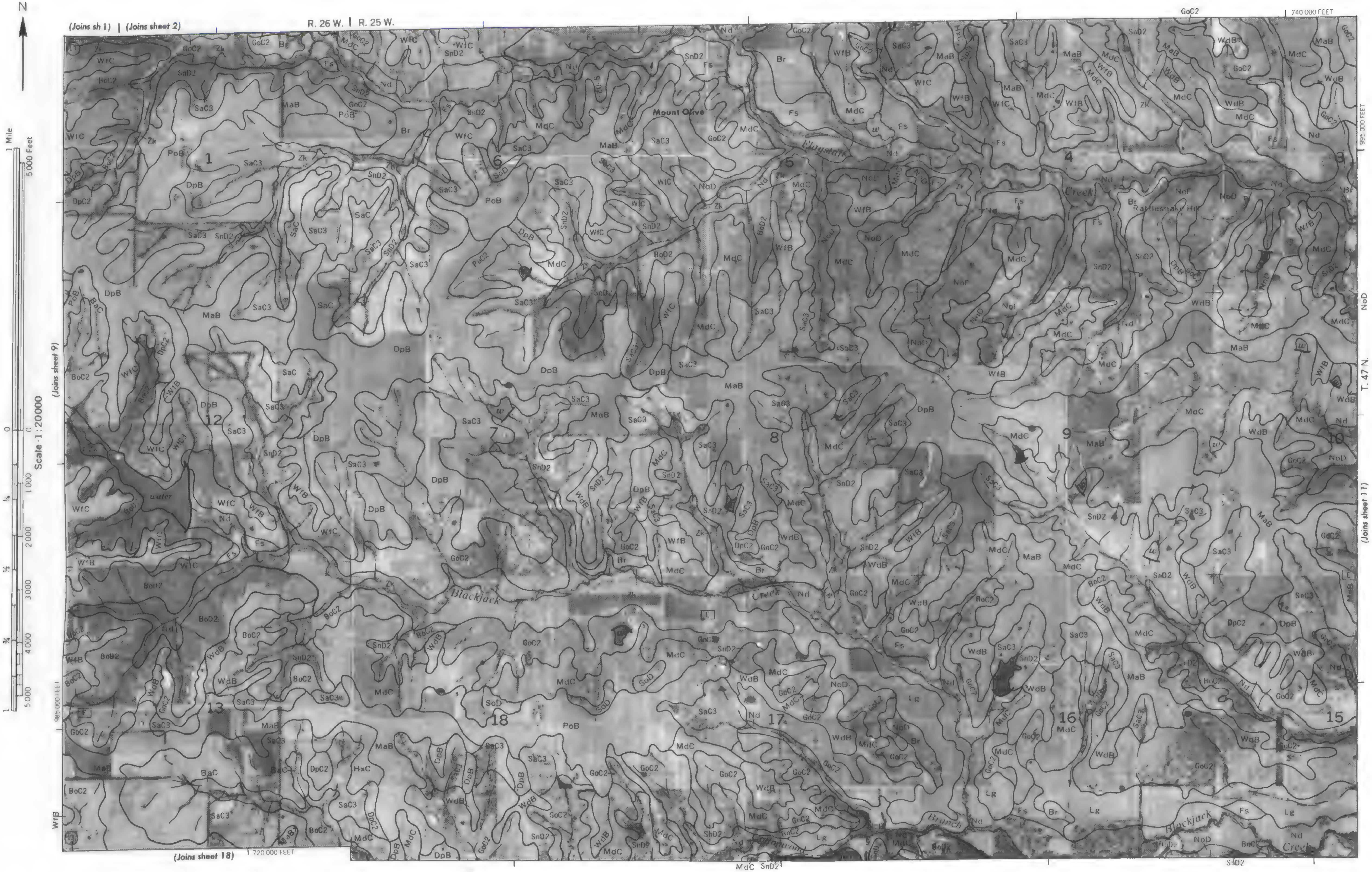

N
LAFAYETTE COUNTY
R. 29 W.
R. 28 W.
T. 47 N.
640 000 FEET
1 000 000 FEET
950 000 FEET
625 000 FEET
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 14)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
River

JOHNSON COUNTY, MISSOURI — SHEET NUMBER 7

Index Map Welcome Page Manuscript


(Joins inset, 5)
(Joins sheet 1)
695 000 FEET
R. 26 W.
T. 47 N
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 17)
715 000 FEET
Robbins
Fayetteville
Walnut Creek
N
1 Mile
5000 Feet
Scale 1:20000

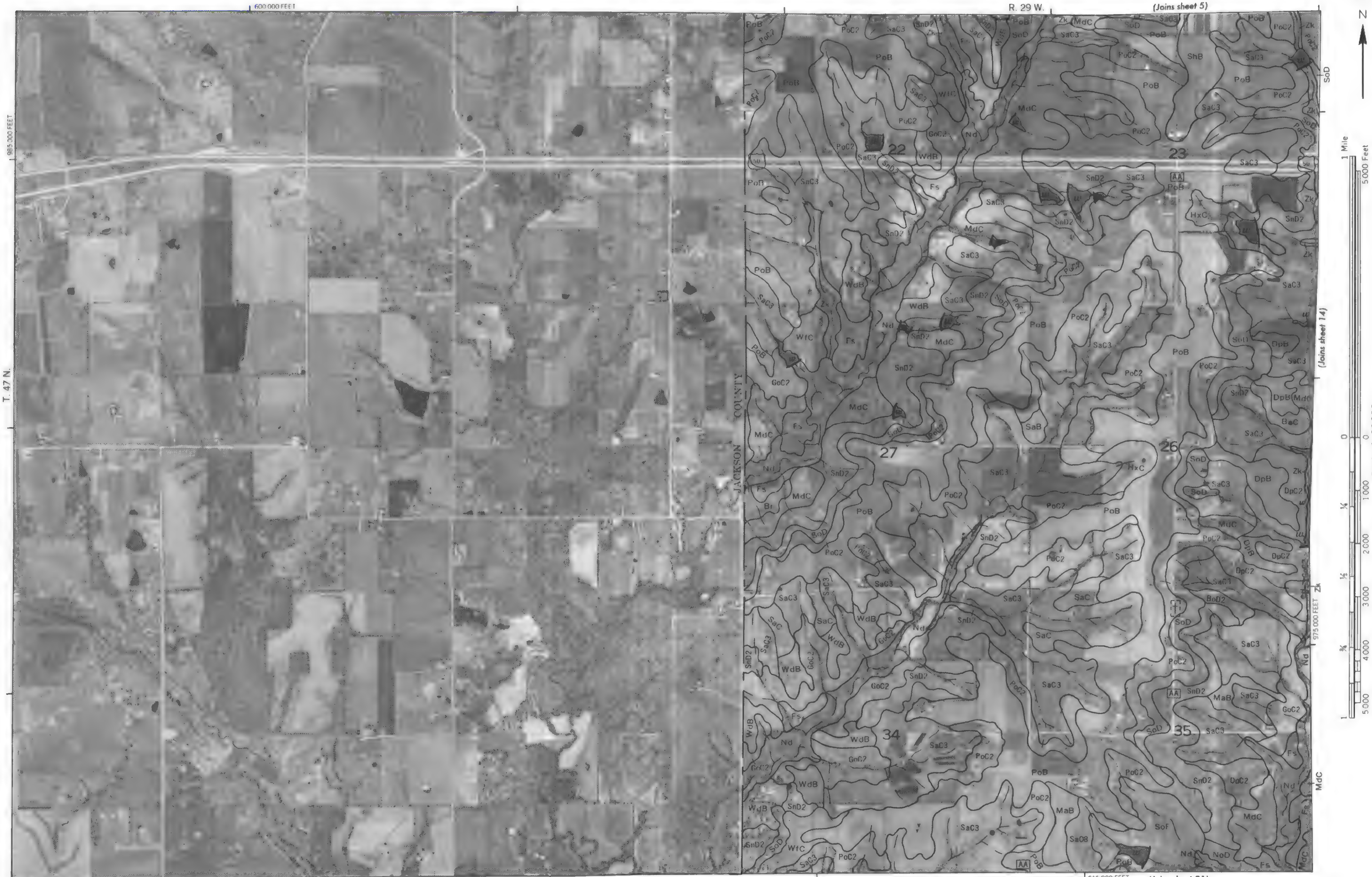
Index Map Welcome Page Manuscript



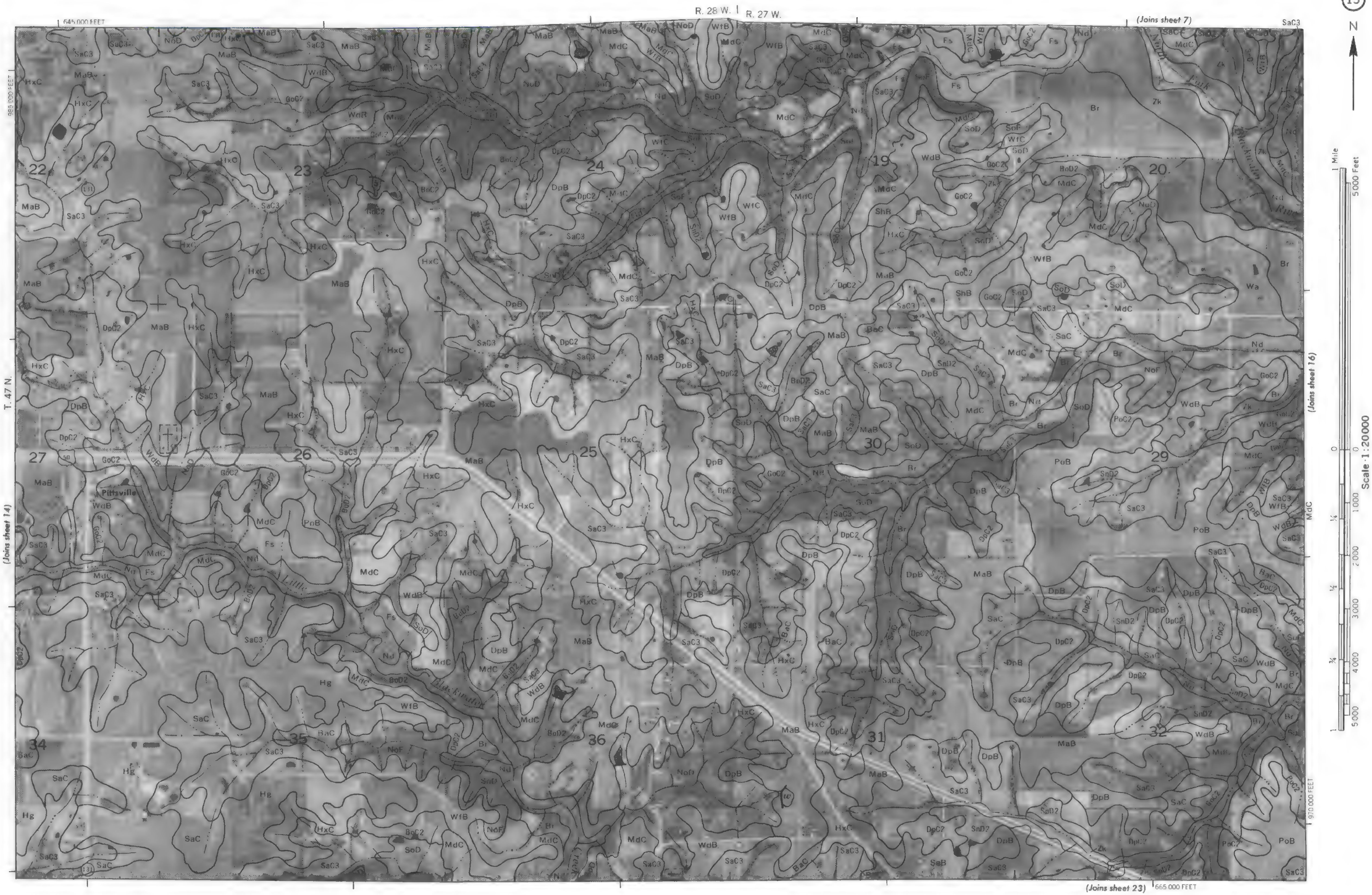
11

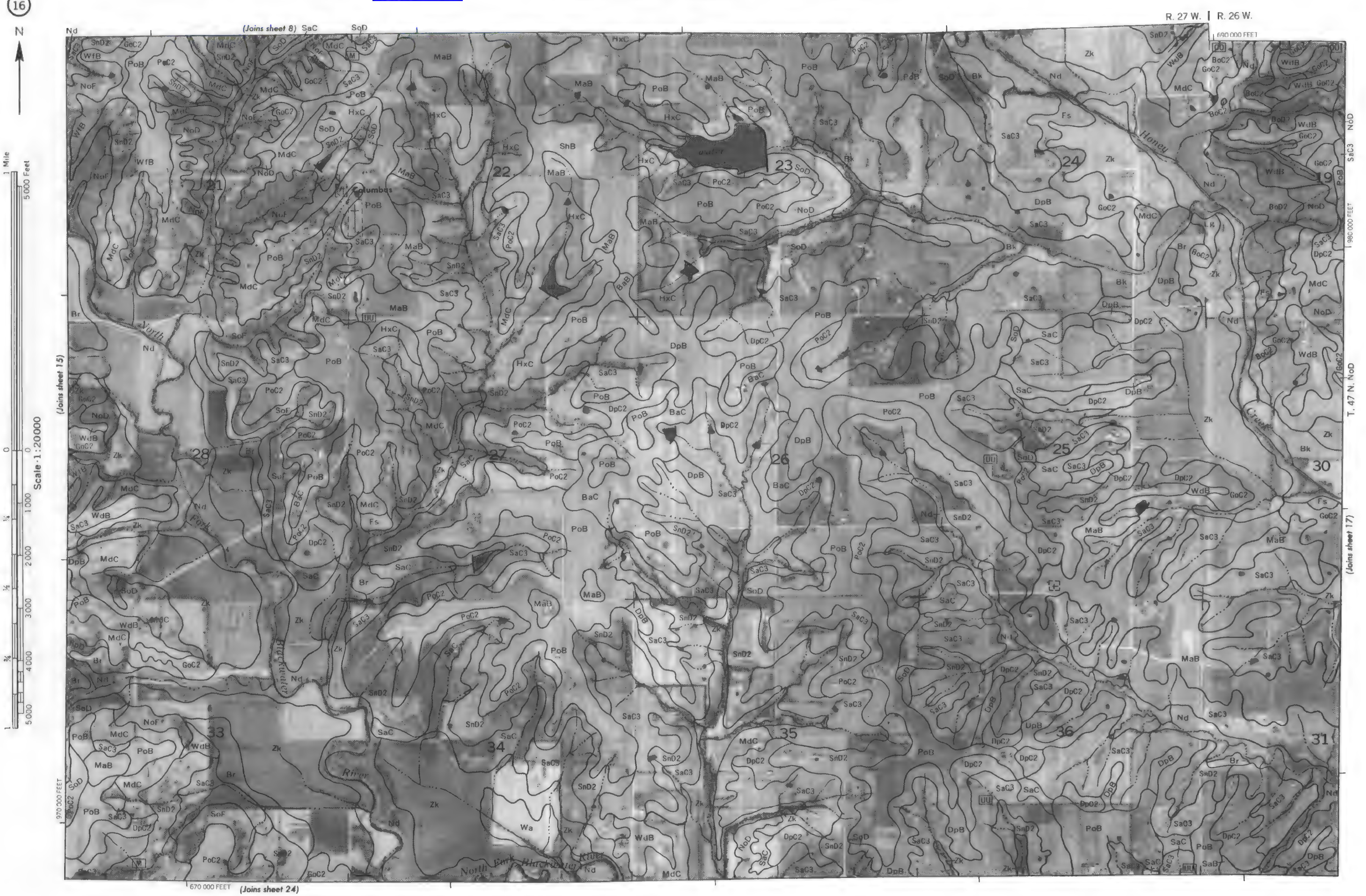

N
(sh 2) | (Joins sheet 3)
745 000 FEET
R. 25 W. | R. 24 W.
995 000 FEET
T. 47 N.
(Joins sheet 10)
(Joins sheet 12)
985 000 FEET
760 000 FEET
(Joins sheet 19)
Flagstaff Creek
Mulkey
Blackwater River
Walnut Creek
Blackjack
Valley City
1 Mile
5 000 Feet
Scale 1:20 000

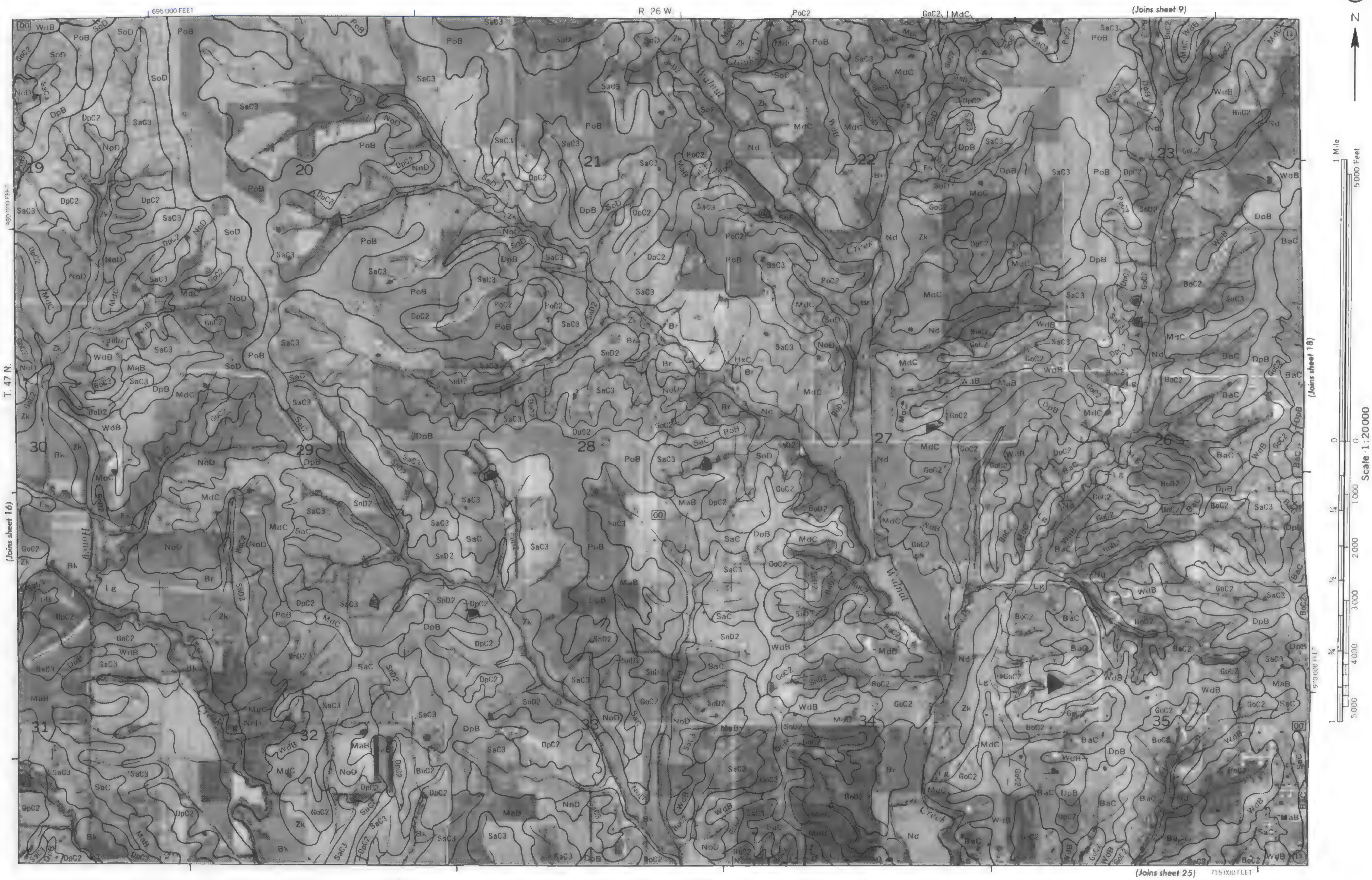

12
N
(Joins 3)
(Joins sheet 4)
R. 24 W.
PETTIS CO
Blackwater River
(Joins sheet 11)
T. 47 N.
PETTIS COUNTY
(Joins sheet 20)
Scale 1:20000
1 Mile
5000 Feet

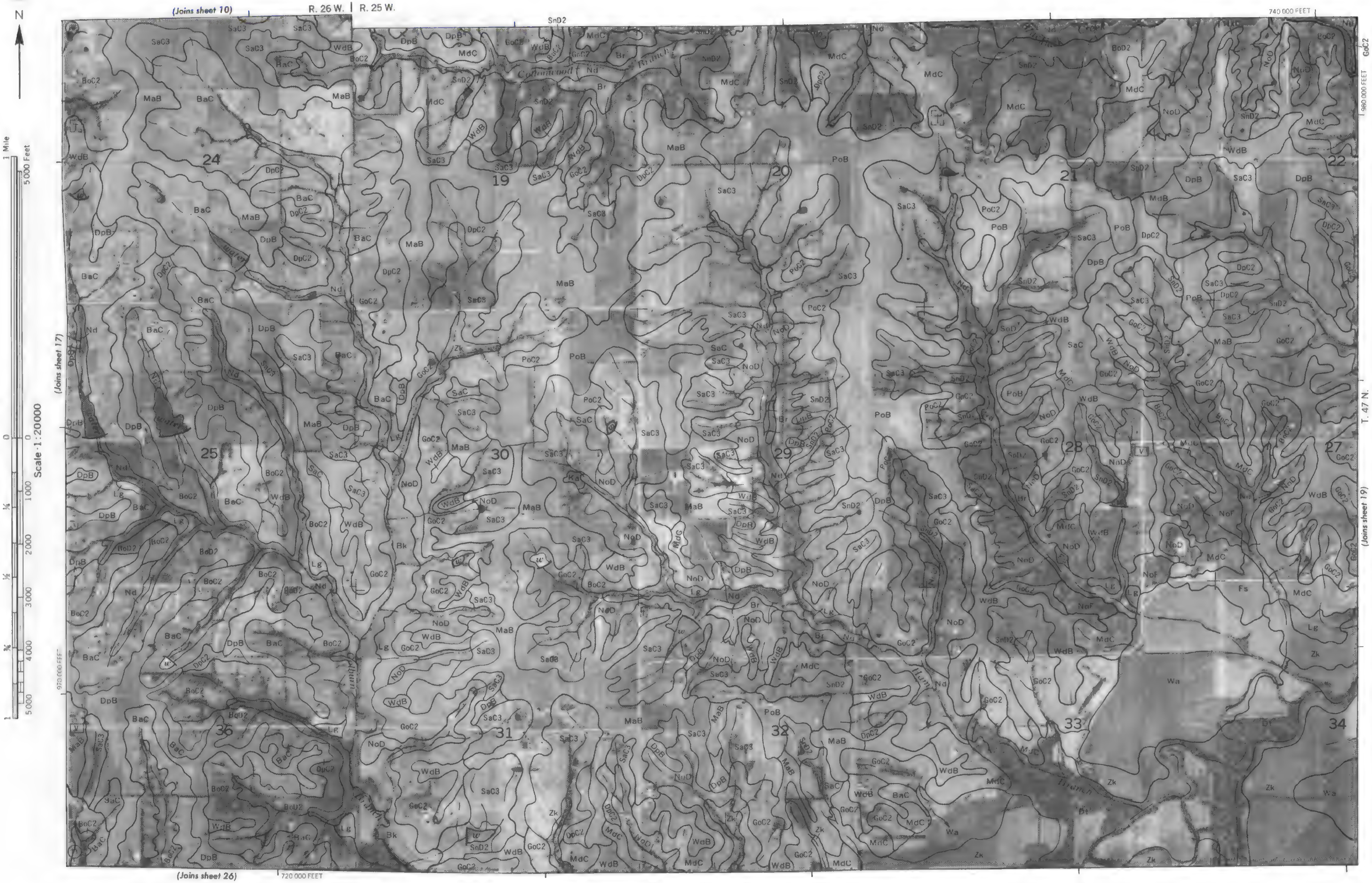

600 000 FEET
R. 29 W.
(Joins sheet 5)
985 000 FEET
T. 47 N.
JACKSON COUNTY
22
23
26
27
34
35
(Joins sheet 14)
975 000 FEET
615 000 FEET
(Joins sheet 21)
N
1 Mile
5000 Feet
Scale 1:20000


(Joins sheet 6)
R. 29 W.
R. 28 W.
N
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Scale 1:20000
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 22)
T. 47 N.
620 000 FEET
640 000 FEET
975 000 FEET
985 000 FEET
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
Elm
water

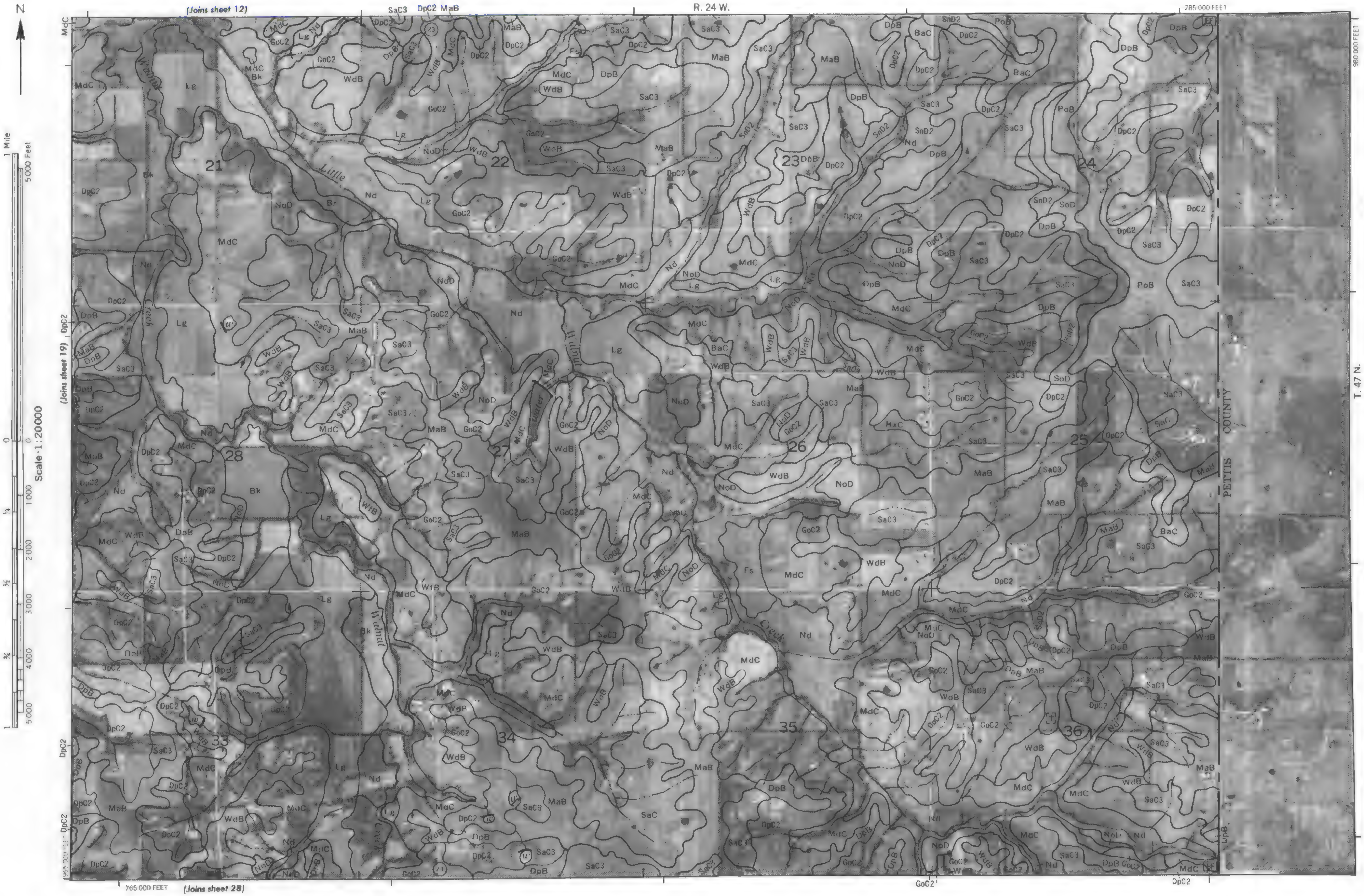

15
N
R. 28 W.
R. 27 W.
T. 47 N.
645 000 FEET
665 000 FEET
985 000 FEET
970 000 FEET
(Joins sheet 7)
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 23)
Pittsville
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


16
N
(Joins sheet 8)
R. 27 W.
R. 26 W.
690 000 FEET
980 000 FEET
T. 47 N.
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 24)
670 000 FEET
970 000 FEET
Columbus
North Fork
Blackwater River
Honey Creek
Scale 1:20000
1 Mile
5000 Feet
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31

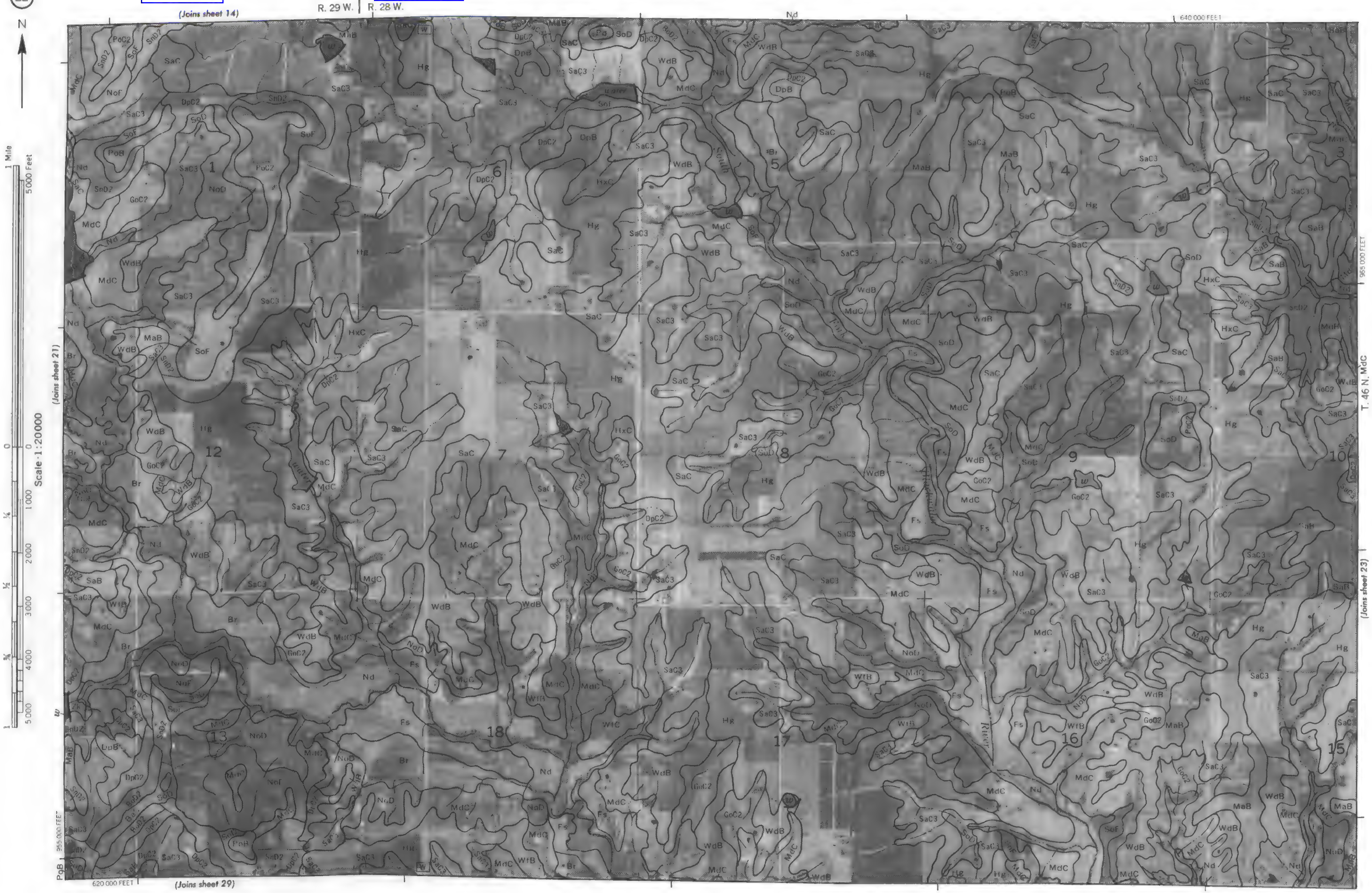

17
N
695 000 FEET
R. 26 W.
(Joins sheet 9)
T. 47 N.
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 25)
715 000 FEET
1 Mile
5000 Feet
Scale 1:20000
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35


18
N
(Joins sheet 10)
R. 26 W.
R. 25 W.
740 000 FEET
980 000 FEET
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 26)
720 000 FEET
970 000 FEET
T. 47 N.
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
Cottonwood
Branch
Coburn
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36


745 000 FEET
R. 25 W.
R. 24 W.
(Joins sheet 11)
380 000 FEET
T. 47 N.
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 27)
760 000 FEET
965 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36
Blackwater River
Clear Fork

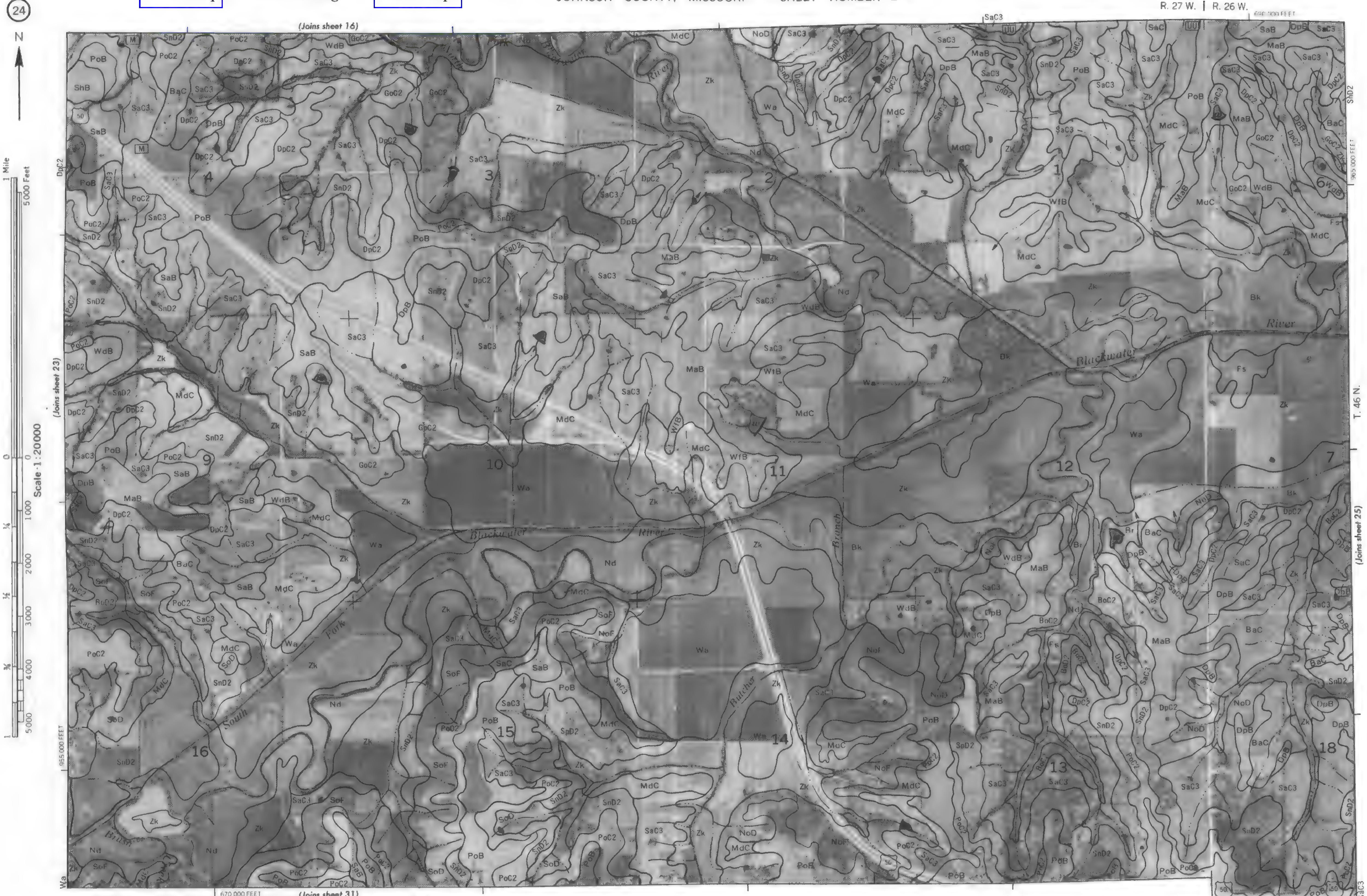

N
(Joins sheet 12)
R. 24 W.
785 000 FEET
980 000 FEET
T. 47 N.
PETTIS COUNTY
(Joins sheet 19)
(Joins sheet 28)
765 000 FEET
965 000 FEET
Scale 1:20 000
1 Mile
5000 Feet
Little
Walnut
Creek
21
22
23
24
25
26
27
28
33
34
35
36


21
N
R. 29 W.
PoB (Joins lower right)
(Joins sheet 13)
T. 46 N.
CASS COUNTY
(Joins sheet 29)
(Joins sheet 22)
(Joins sheet 36)
(Joins inset)
610 000 FEET
615 000 FEET
950 000 FEET
940 000 FEET
970 000 FEET
955 000 FEET
RAILROAD
DEVIL RIDGE
water
22
23
27
26
34
35
3
2
10
11
15
14
1 Mile
5000 Feet
Scale 1:20000

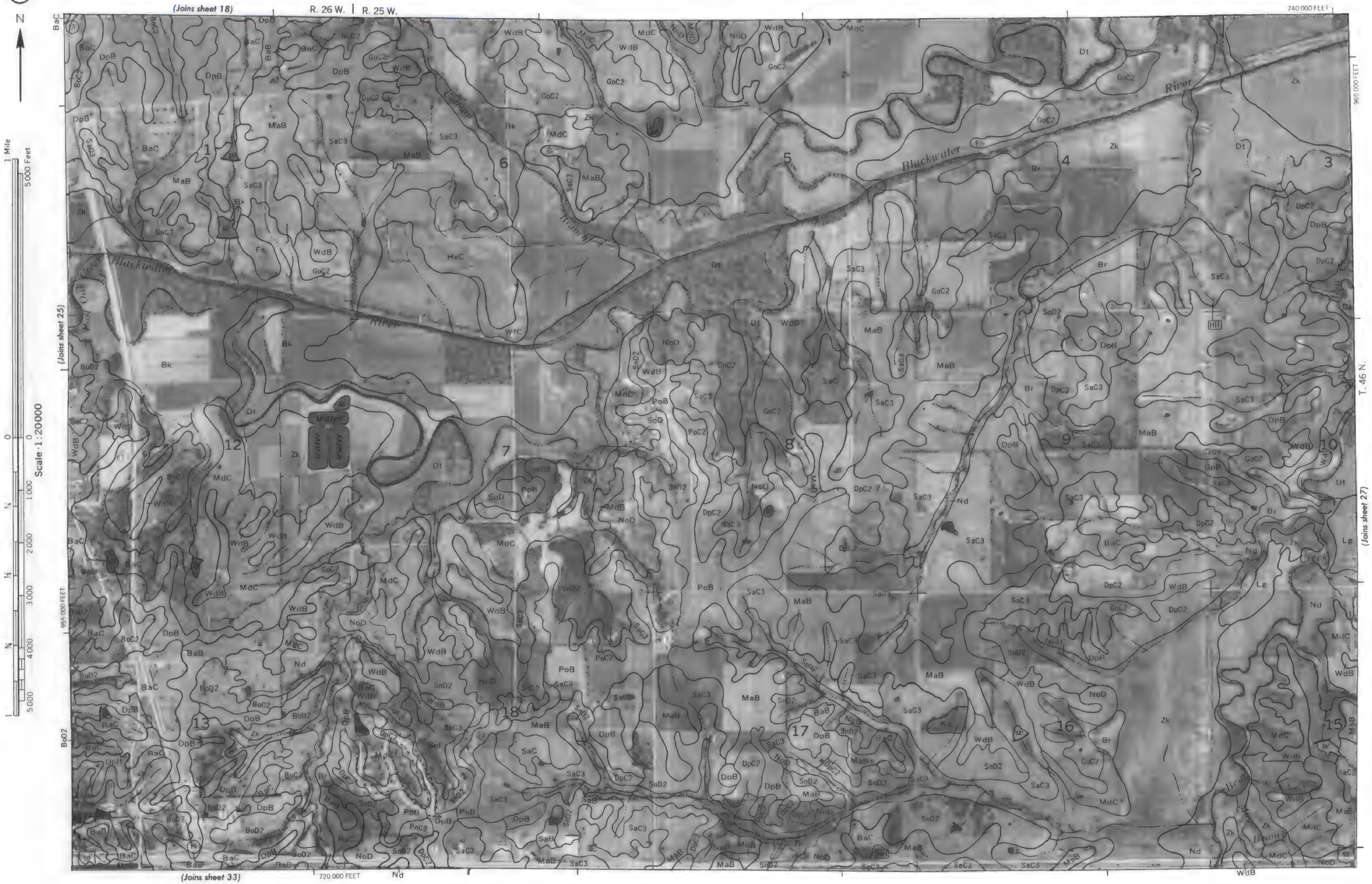

(Joins sheet 14)
R. 29 W.
R. 28 W.
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 29)
T. 46 N.
640 000 FEET
965 000 FEET
620 000 FEET
955 000 FEET


23
N
R. 28 W. | R. 27 W.
(Joins sheet 15)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 30)
T. 46 N.
645 000 FEET
665 000 FEET
955 000 FEET
1 Mile
5000 Feet
Scale 1:20000
South Fork Blackwater River
Little Blackwater
Creek

JOHNSON COUNTY, MISSOURI — SHEET NUMBER 24

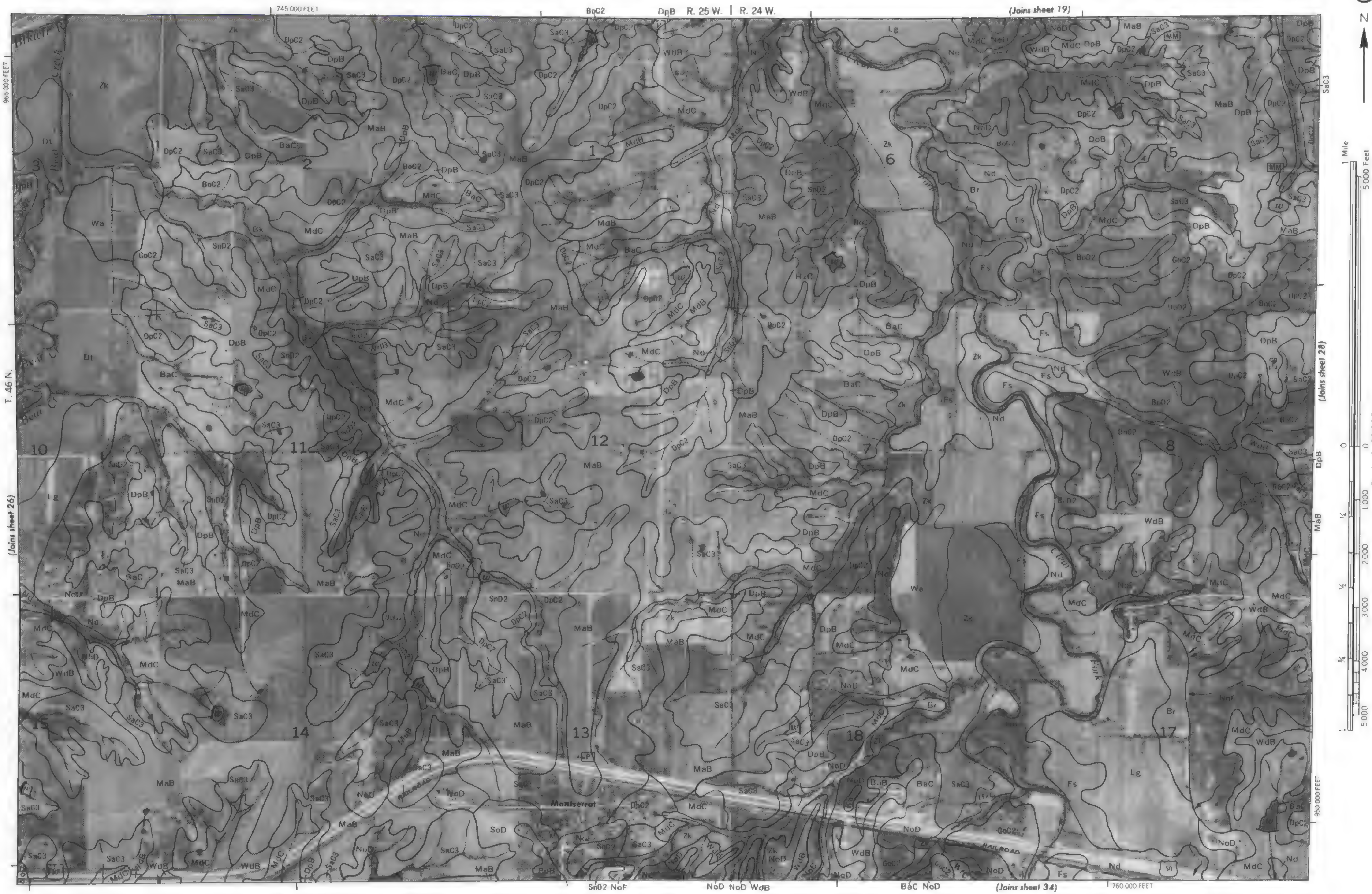



25
N
695 000 FEET
R. 26 W.
(Joins sheet 17)
(Joins sheet 26)
(Joins sheet 24)
(Joins sheet 32)
T. 46 N.
965 000 FEET
715 000 FEET
Blackwater River
Honey Creek
Walnut Creek
Ork Creek
Devils Branch
Sky Haven Airport
water
1 Mile
5 000 Feet
Scale 1:20000
0
1/4
1/2
3/4
1
1000
2000
3000
4000
5000


N
(Joins sheet 18)
R. 26 W.
R. 25 W.
740 000 FEET
965 000 FEET
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 33)
720 000 FEET
955 000 FEET
T. 46 N.
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
Blackwater
River
Blackwater River
Coburn Branch
Post Oak Creek
Creek
Bear Branch
Water
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

Index Map Welcome Page Manuscript

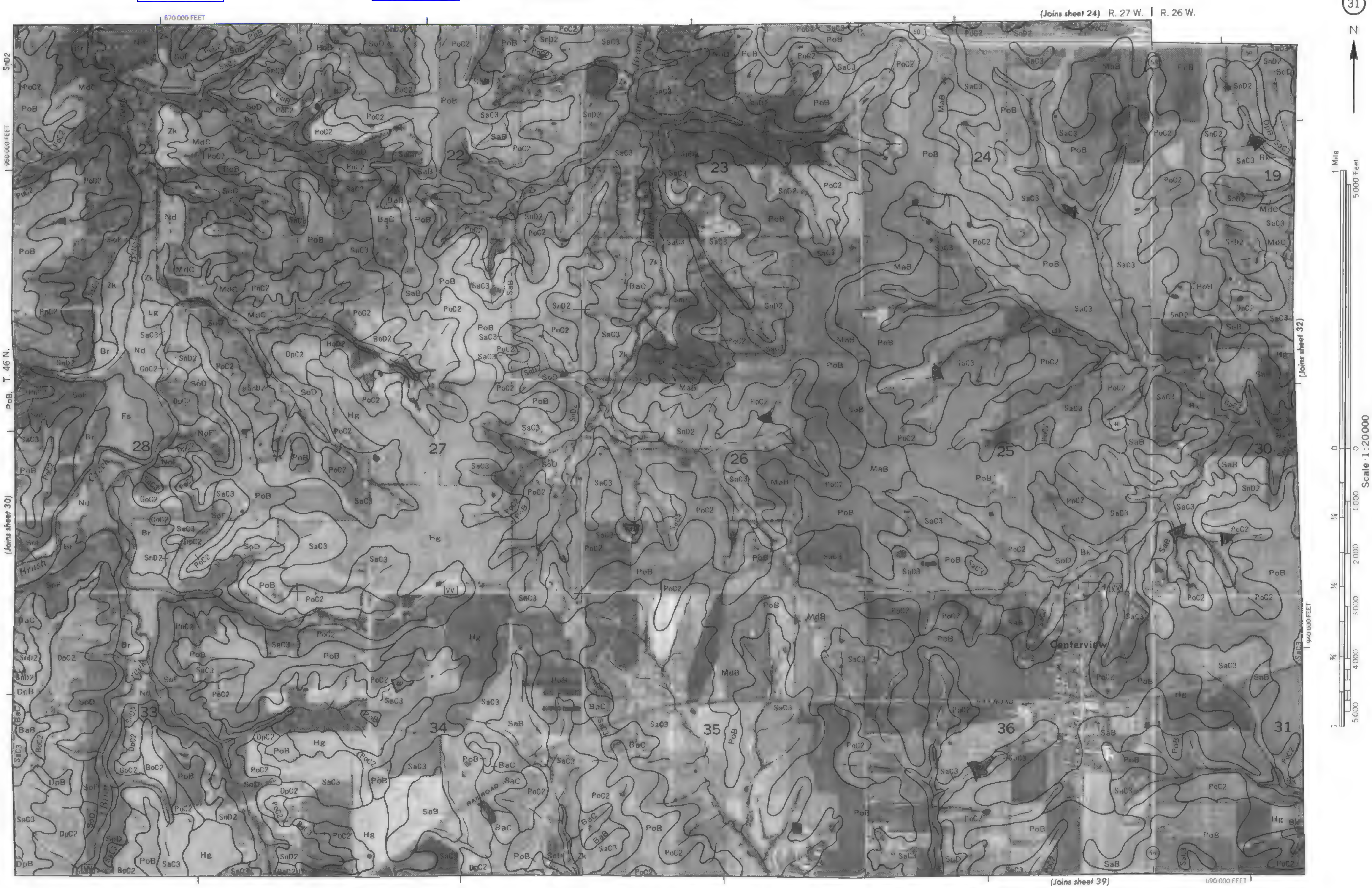
JOHNSON COUNTY, MISSOURI — SHEET NUMBER 27



Index Map Welcome Page Manuscript

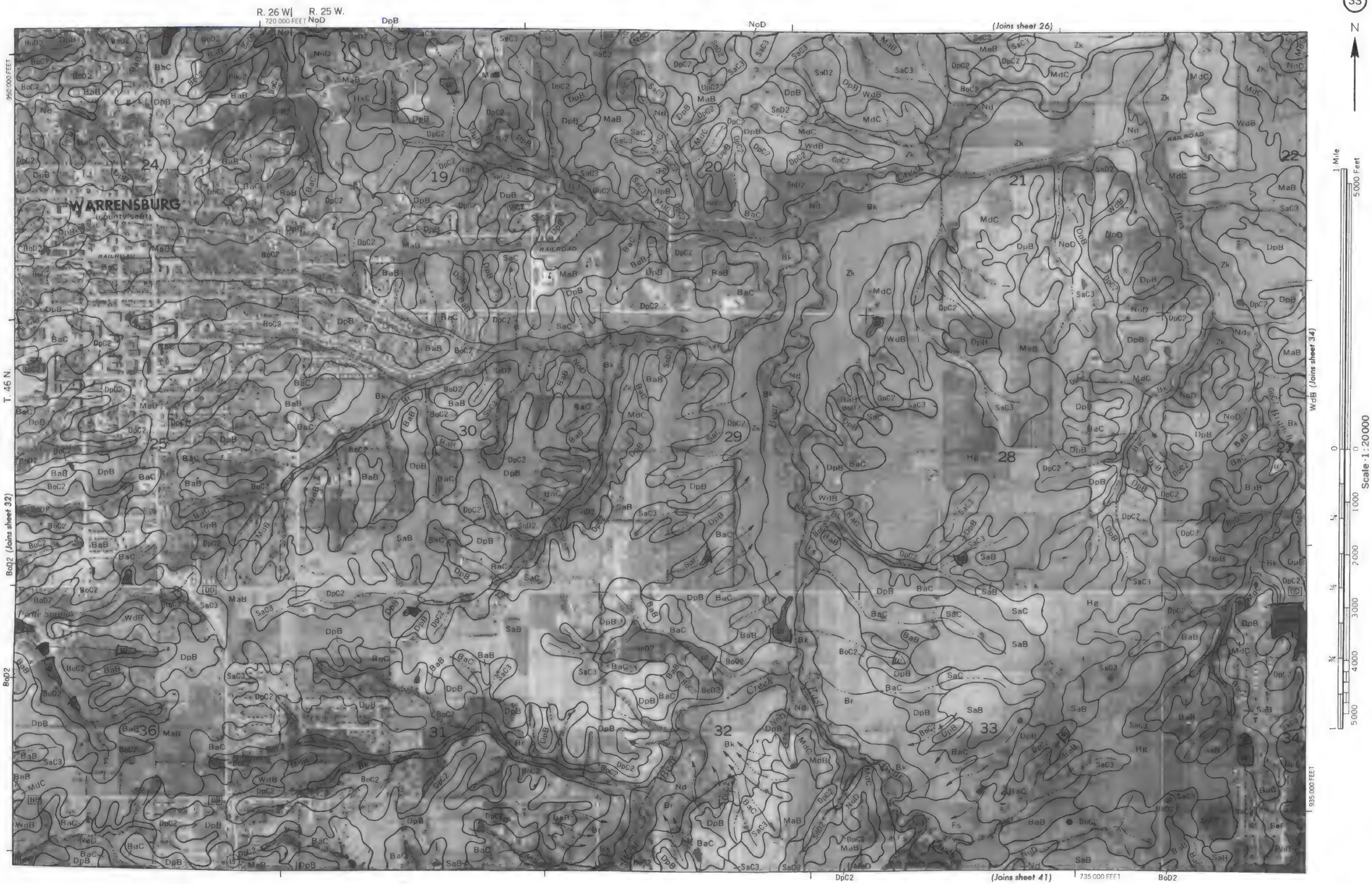

29
N
R. 29 W.
R. 28 W.
620 000 FEET
(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 37)
(Joins inset, sheet 21)
950 000 FEET
940 000 FEET
640 000 FEET
T. 46 N.
Blackwater
River
Fork
Kingsville
RAILROAD
water
1 Mile
5000 Feet
Scale 1:20000
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34


N
(Joins sheet 23)
R. 28 W. | R. 27 W.
665 000 FEET
950 000 FEET
T. 46 N.
(Joins sheet 31)
(Joins sheet 29)
(Joins sheet 38)
645 000 FEET
940 000 FEET
Scale 1:20000
1 Mile
5 000 Feet
Blackwater
South Fork
Blackwater River
Pin Oak Creek
Water
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36


(Joins sheet 24)
R. 27 W.
R. 26 W.
31
N
670 000 FEET
950 000 FEET
940 000 FEET
690 000 FEET
T. 46 N.
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 39)
Scale 1:20000
1 Mile
5 000 Feet
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
Centerview
Brush
Creek
RAILROAD

Index Map Welcome Page Manuscript

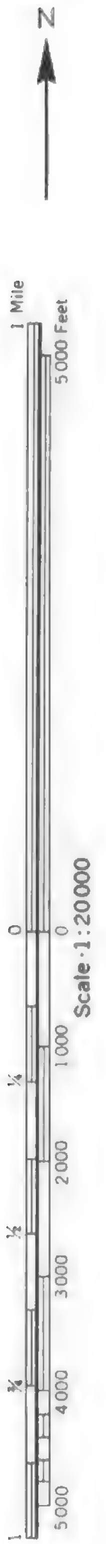
33



R. 26 W.
R. 25 W.
720 000 FEET
(Joins sheet 26)
950 000 FEET
T. 46 N.
(Joins sheet 32)
WARRENSBURG
(county seat)
RAILROAD
Creek
(Joins sheet 34)
(Joins sheet 41)
735 000 FEET
935 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000


34
N
Scale 1:20000
1 Mile
5000 Feet
(Joins sheet 27)
R. 25 W. R. 24 W.
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 42)
T. 46 N.
740 000 FEET
760 000 FEET
945 000 FEET
935 000 FEET
water
RAILROAD
BRISTLE RIDGE
KNOB NOSTER STATE PARK
Creek
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


35
N
R. 24 W.
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 43)
765 000 FEET
785 000 FEET
945 000 FEET
935 000 FEET
T. 46 N.
KNOB NOSTER
KNOB NOSTER STATE PARK
RAILROAD
WHITEMAN AIR FORCE BASE
PETTIS COUNTY
1 Mile
5 000 Feet
Scale 1:20000
21
22
23
24
25
26
27
28
33
34
35
36

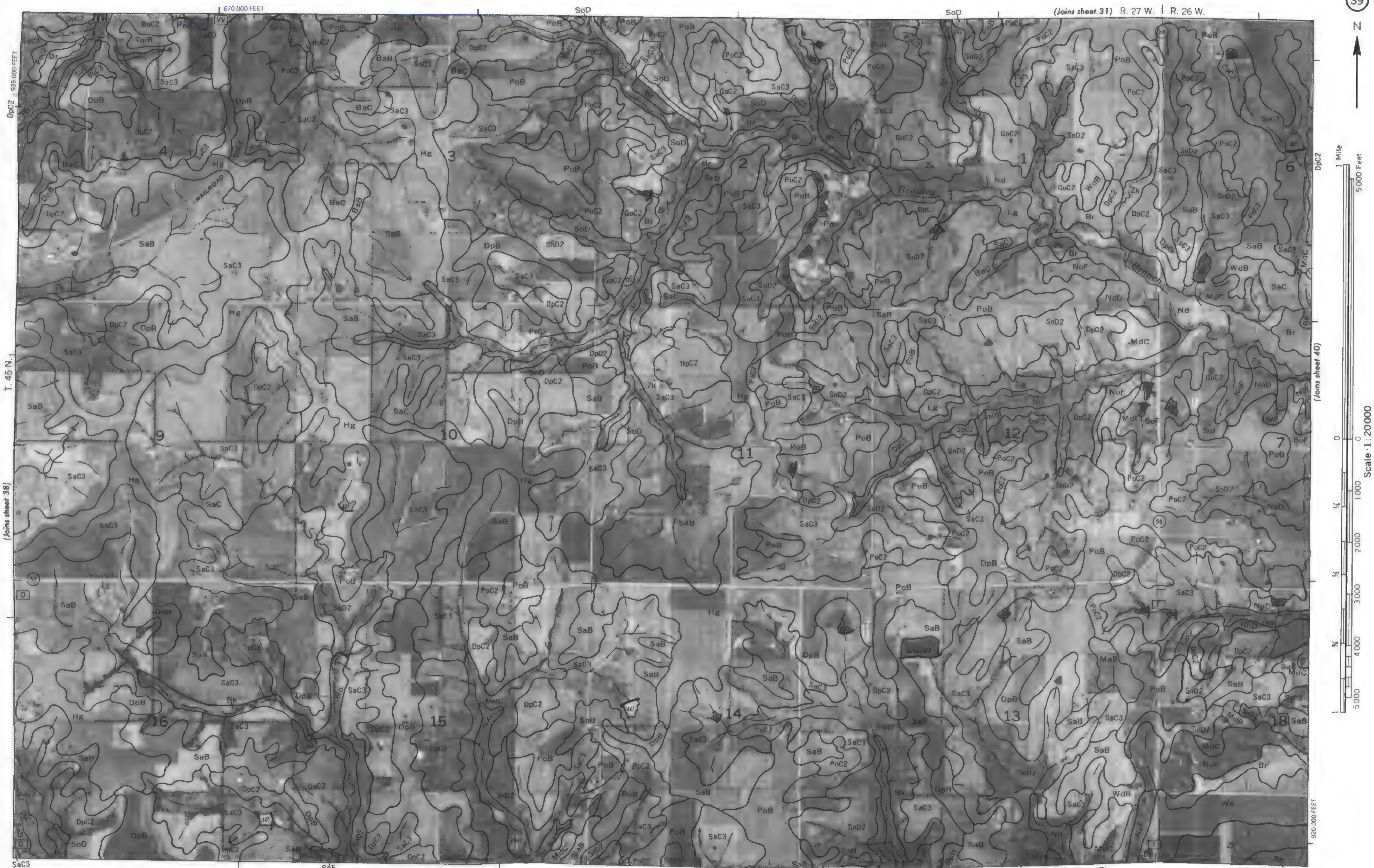

N
1 Mile
5 000 Feet
Scale 1:20000
0
1 000
2 000
3 000
4 000
5 000


R. 29 W.
615 000 FEET
(Joins sheet 44)
(Joins 45)
905 000 FEET
T. 44 N.
(Joins sheet 52)
CASS COUNTY
895 000 FEET
610 000 FEET
(Joins inset, sheet 44)
Branch
Camp
RAILROAD
La Tour

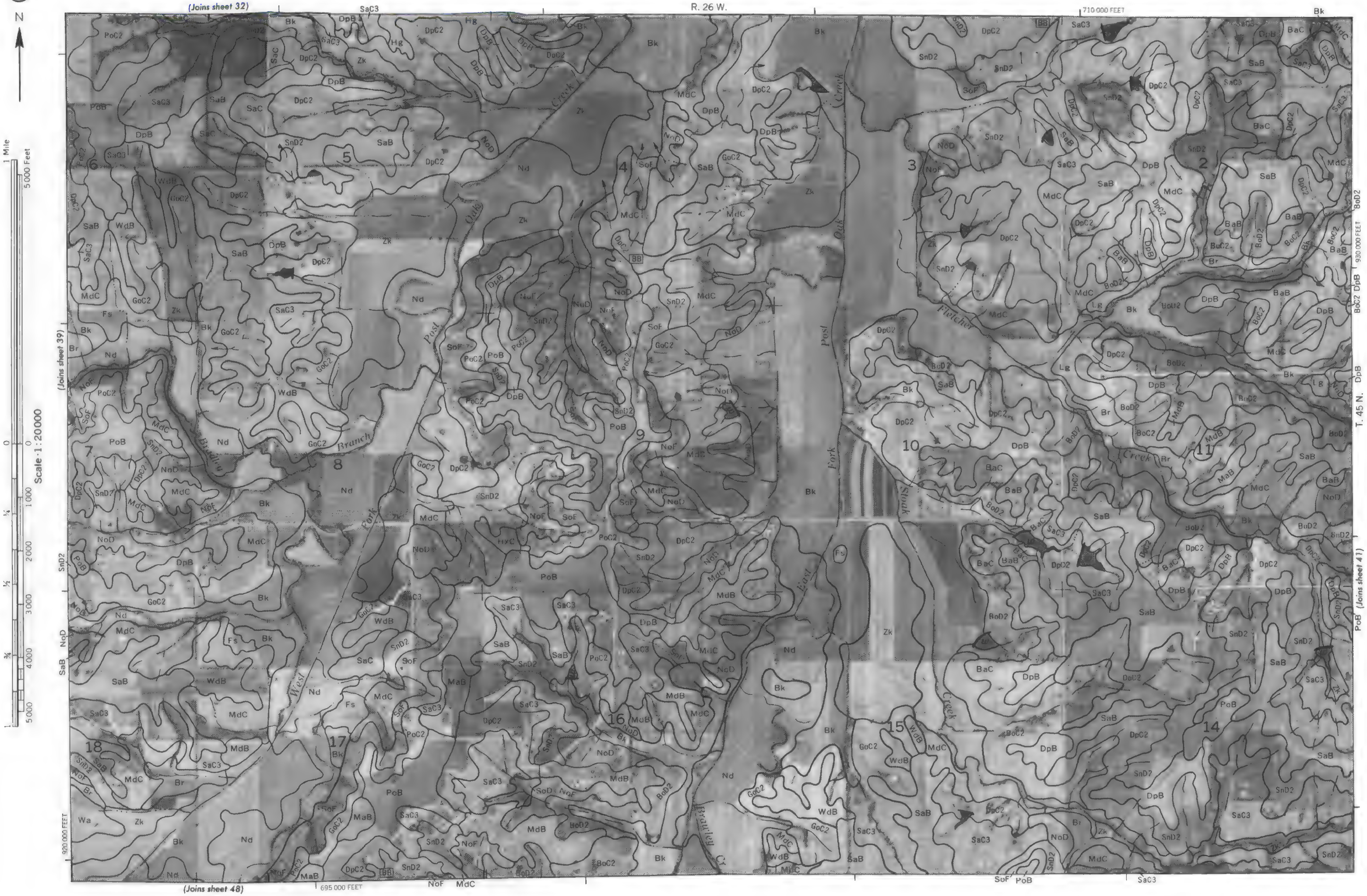

(Joins inset, sheet 21)
R. 29 W.
Louse
Run
CASS COUNTY
T. 45 N.
(Joins sheet 37)
935 000 FEET
925 000 FEET
water
(Joins sheet 44)
610 000 FEET

R. 29 W. | R. 28 W.
620 000 FEET
935 000 FEET
T. 45 N.
(Joins sheet 29)
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 45)
640 000 FEET
925 000 FEET
Kingsville
37
N
Scale 1:20000
1 Mile
5000 Feet

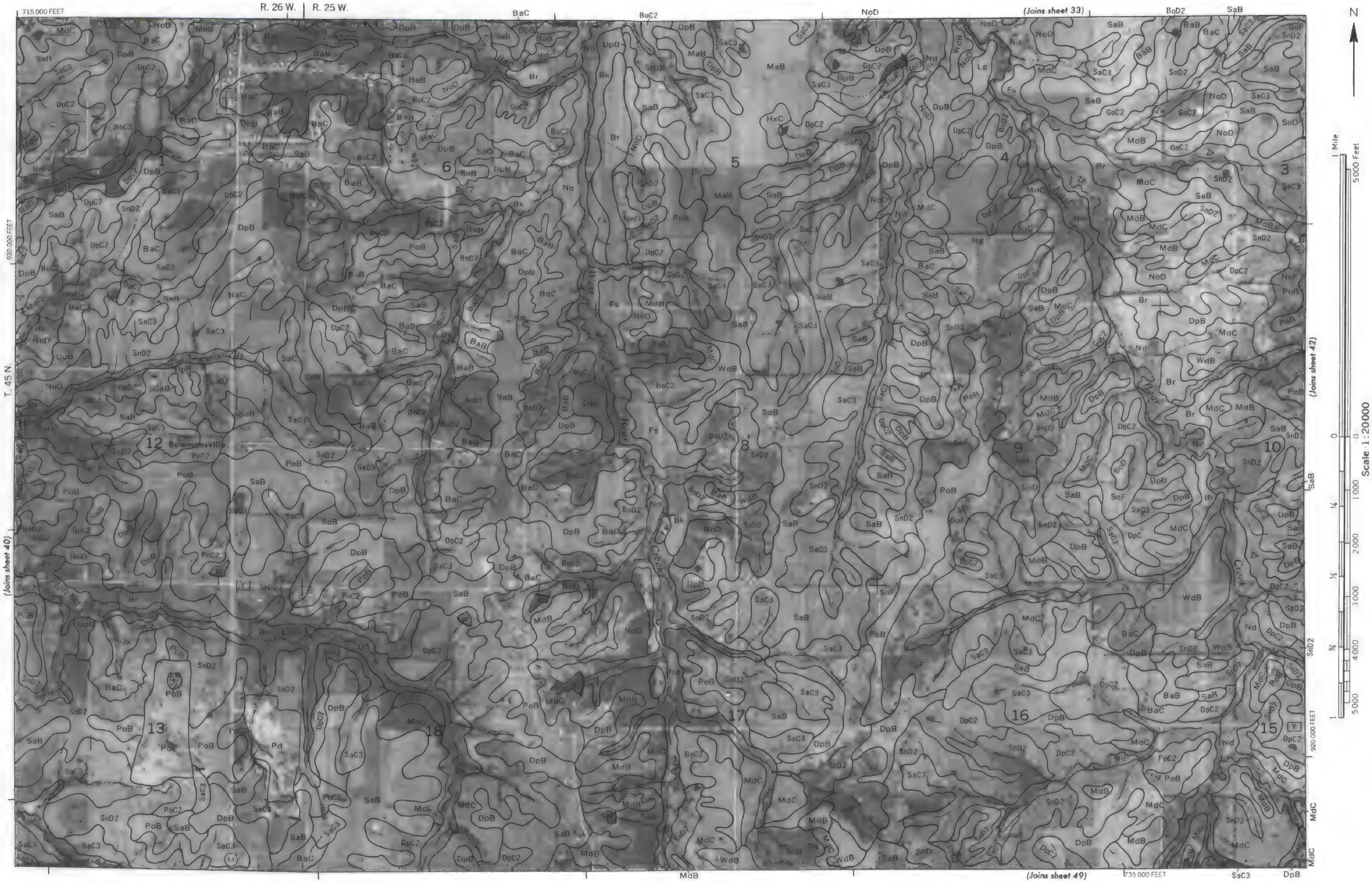
JOHNSON COUNTY, MISSOURI — SHEET NUMBER 38

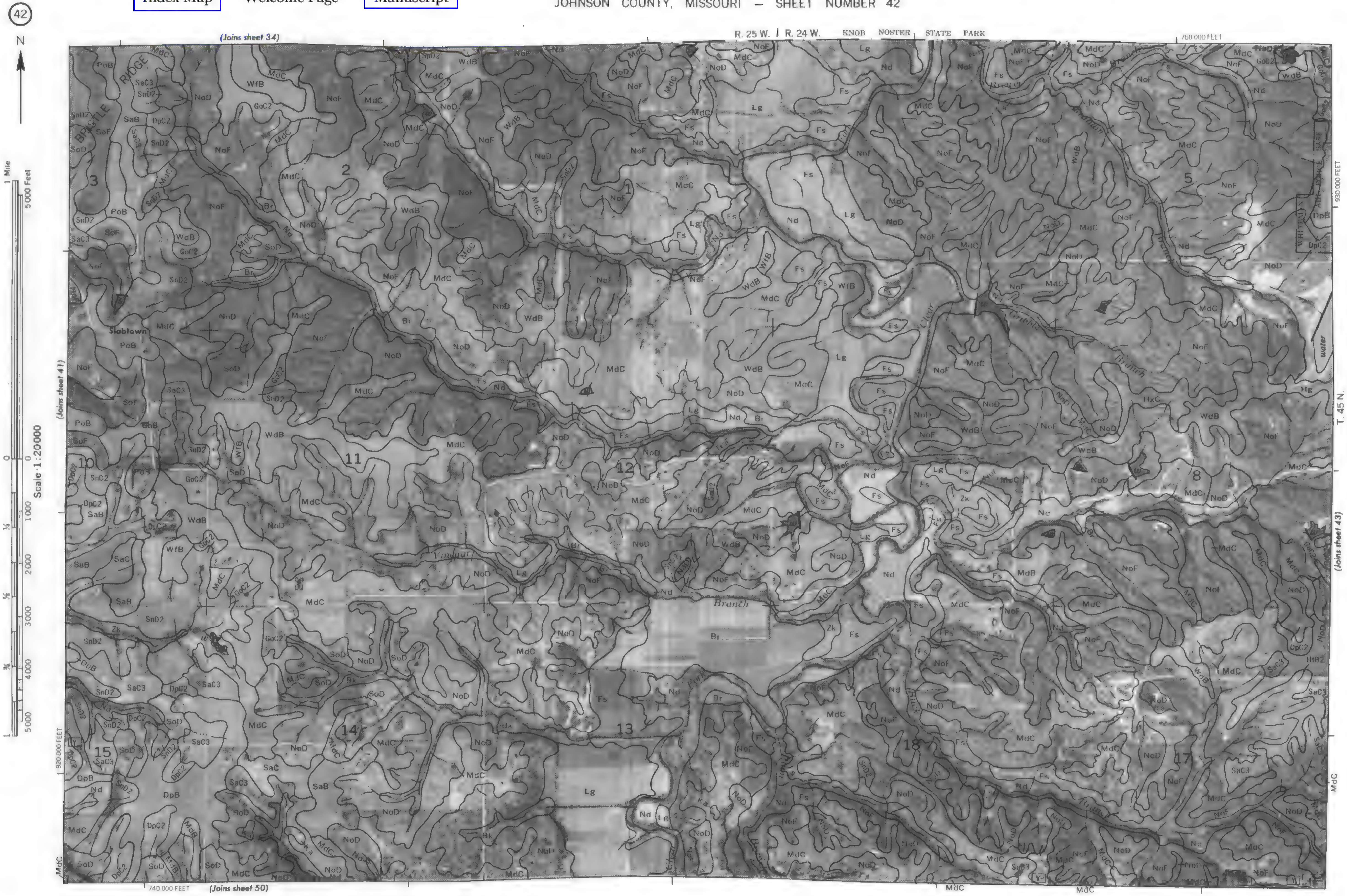

39
N
(Joins sheet 31)
R. 27 W.
R. 26 W.
670 000 FEET
935 000 FEET
T. 45 N.
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 47)
920 000 FEET
690 000 FEET
RAILROAD
1 Mile
5000 Feet
Scale 1:20000

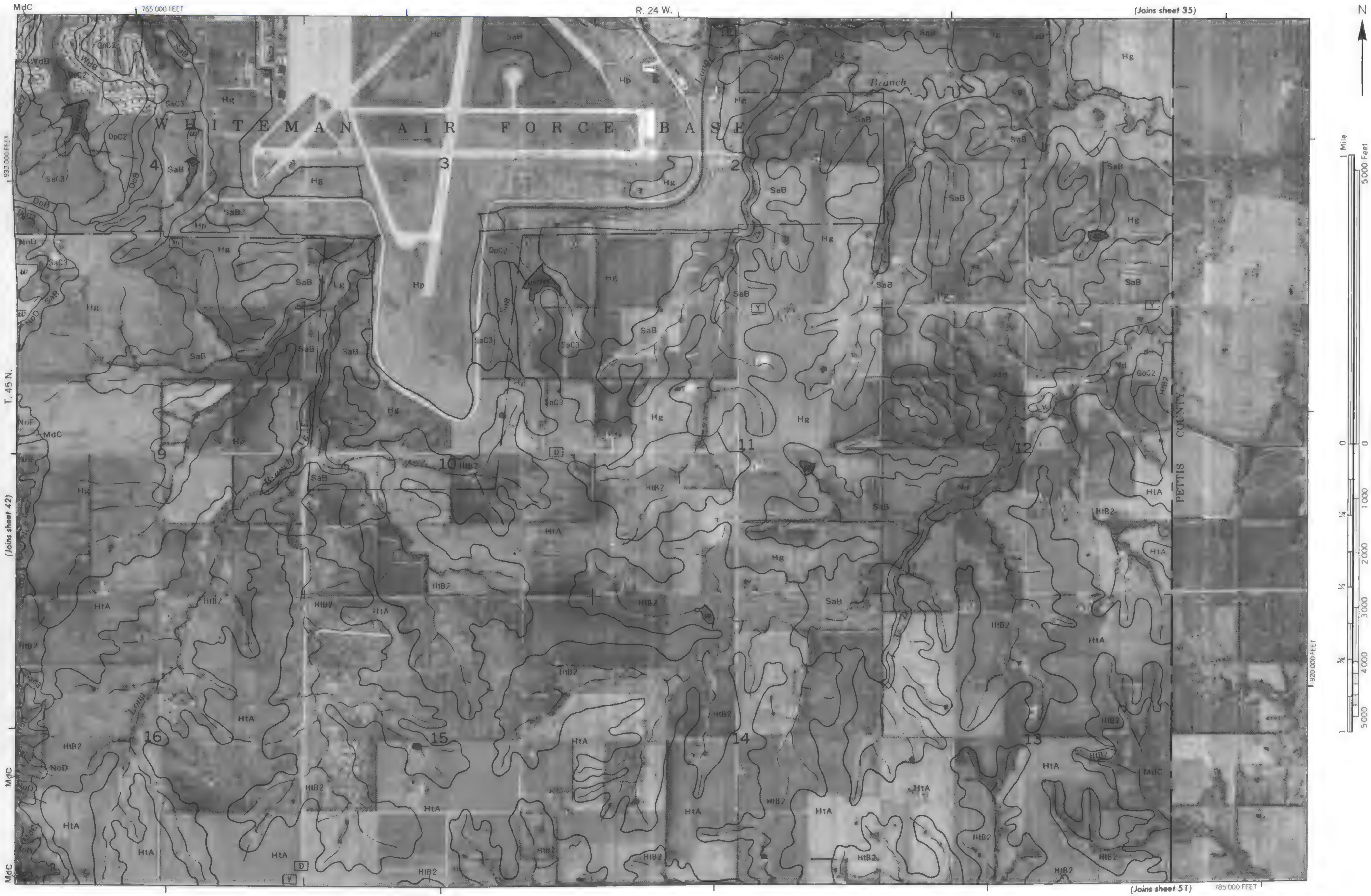
(40)

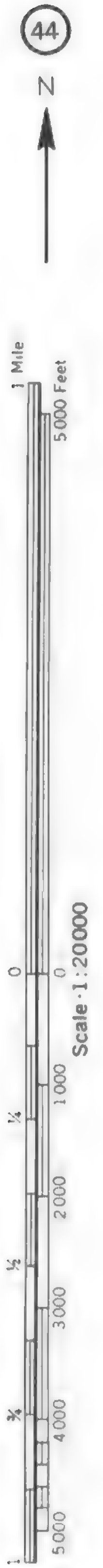

N
(Joins sheet 32)
R. 26 W.
710 000 FEET
(Joins sheet 39)
(Joins sheet 41)
T. 45 N.
930 000 FEET
920 000 FEET
(Joins sheet 48)
695 000 FEET
Scale 1:20000
1 Mile
5000 Feet
Post
Oak
Creek
Fletcher
Creek
Branch
Fork
West
East
Fork
Brawley
Cr.
Sloan
Creek

JOHNSON COUNTY, MISSOURI — SHEET NUMBER 41

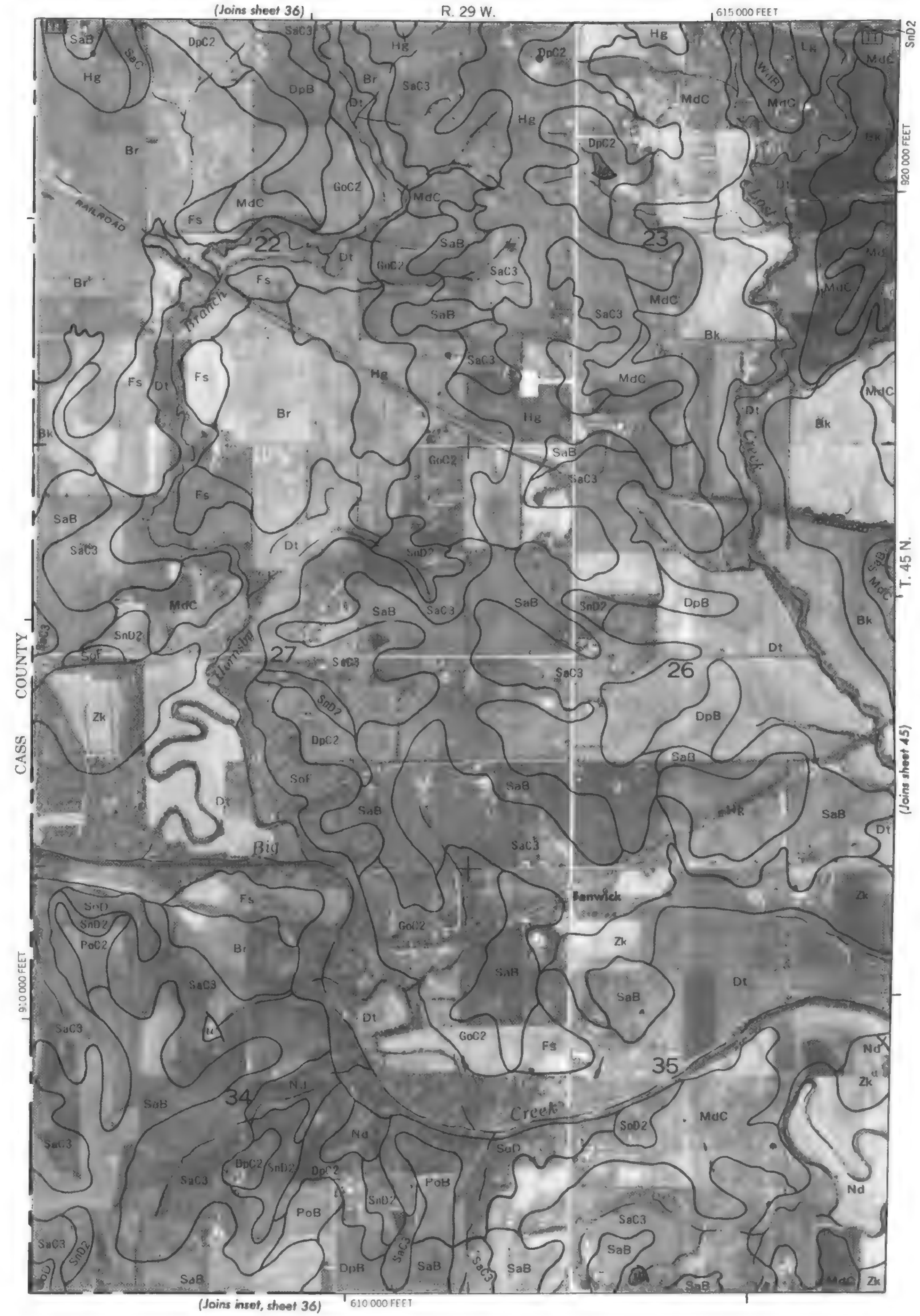



42
N
(Joins sheet 34)
R. 25 W.
R. 24 W.
KNOB NOSTER STATE PARK
760 000 FEET
930 000 FEET
T. 45 N.
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 50)
740 000 FEET
920 000 FEET
Scale 1:20000
1 Mile
5000 Feet
Slabtown
BRISTLE RIDGE
Clear
Vanguar
Branch
Gribble
Branch
water


43
N
(Joins sheet 35)
R. 24 W.
765 000 FEET
T. 45 N.
(Joins sheet 42)
WHITEMAN AIR FORCE BASE
Branch
Long
PETTIS COUNTY
(Joins sheet 51)
785 000 FEET
920 000 FEET
1 Mile
5000 Feet
Scale 1:20 000


44
N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1000
2000
3000
4000
5000

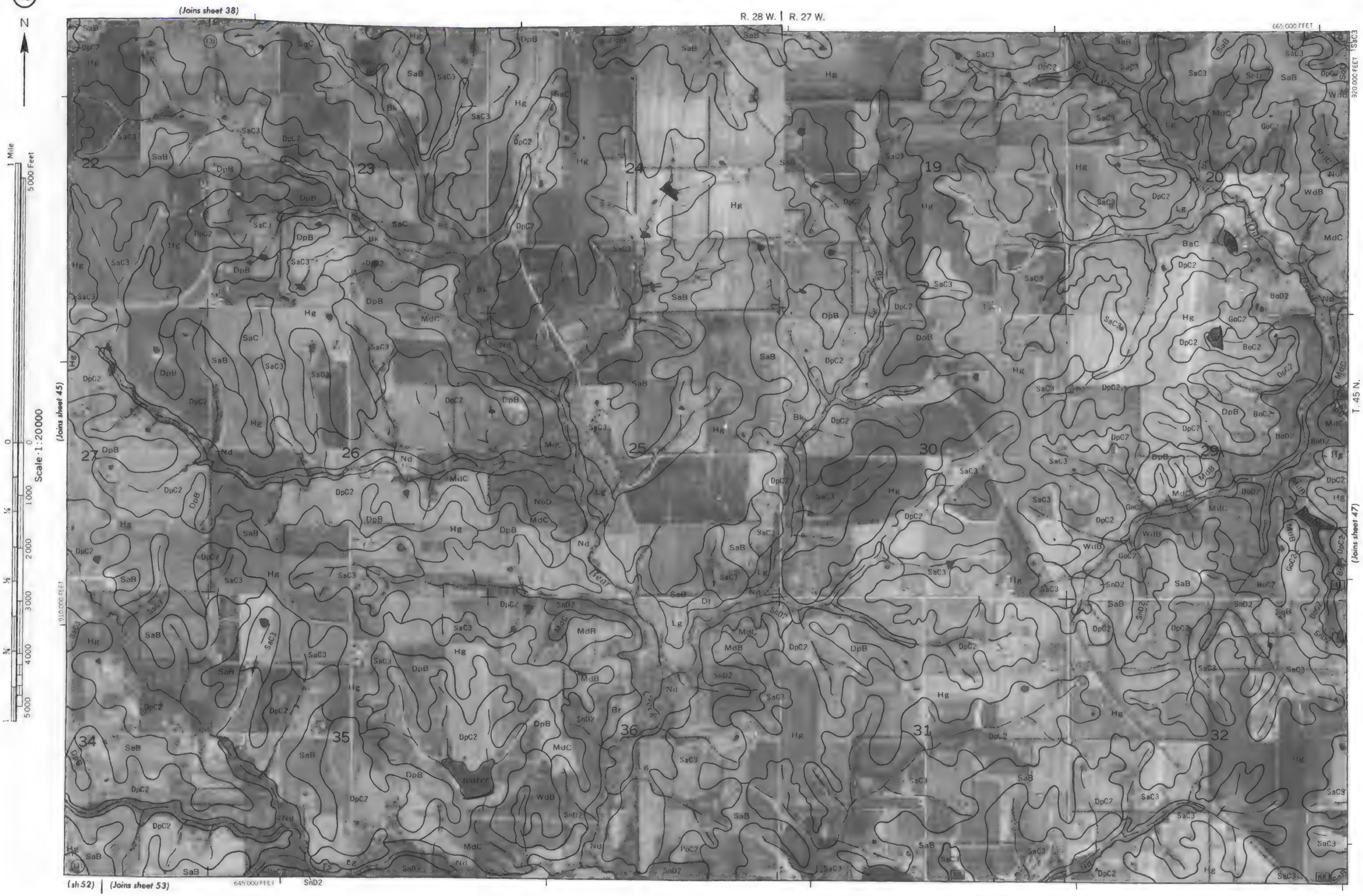

(Joins inset, sheet 36)
R. 29 W.
615 000 FEET
890 000 FEET
T. 44 N.
(Joins sheet 59)
CASS COUNTY
875 000 FEET
610 000 FEET
CASS COUNTY

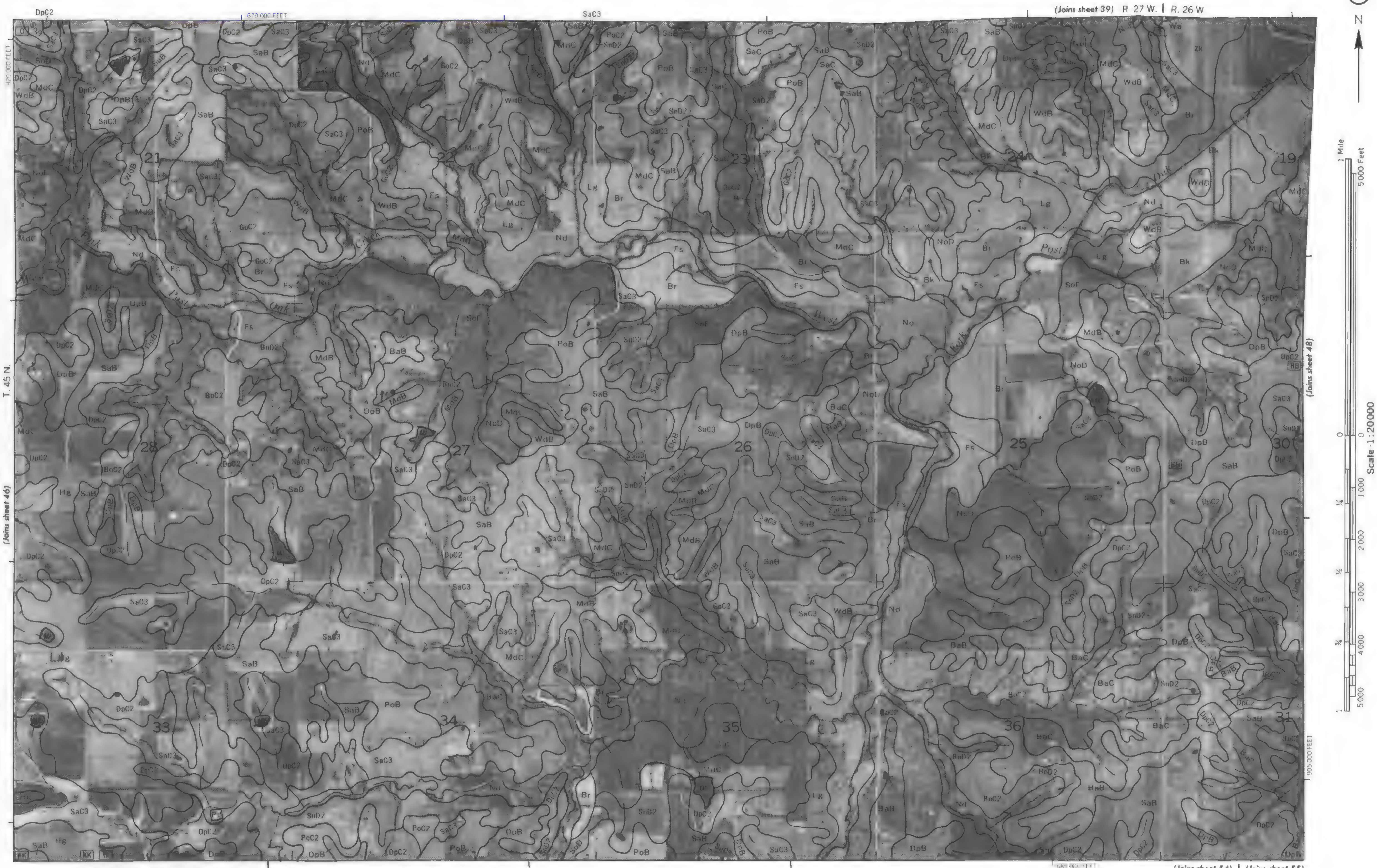

(Joins sheet 36)
R. 29 W.
615 000 FEET
920 000 FEET
T. 45 N.
(Joins sheet 45)
CASS COUNTY
910 000 FEET
RAILROAD
Fenwick
(Joins inset, sheet 36)
610 000 FEET


45
N
R. 29 W.
R. 28 W.
620 000 FEET
(Joins sheet 37)
920 000 FEET
T. 45 N.
(Joins sheet 44)
(Joins sheet 46)
910 000 FEET
640 000 FEET
(inset, 36)
(Joins sheet 52)
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
Medford
1 Mile
5000 Feet
Scale 1:20000

46

JOHNSON COUNTY, MISSOURI — SHEET NUMBER 46

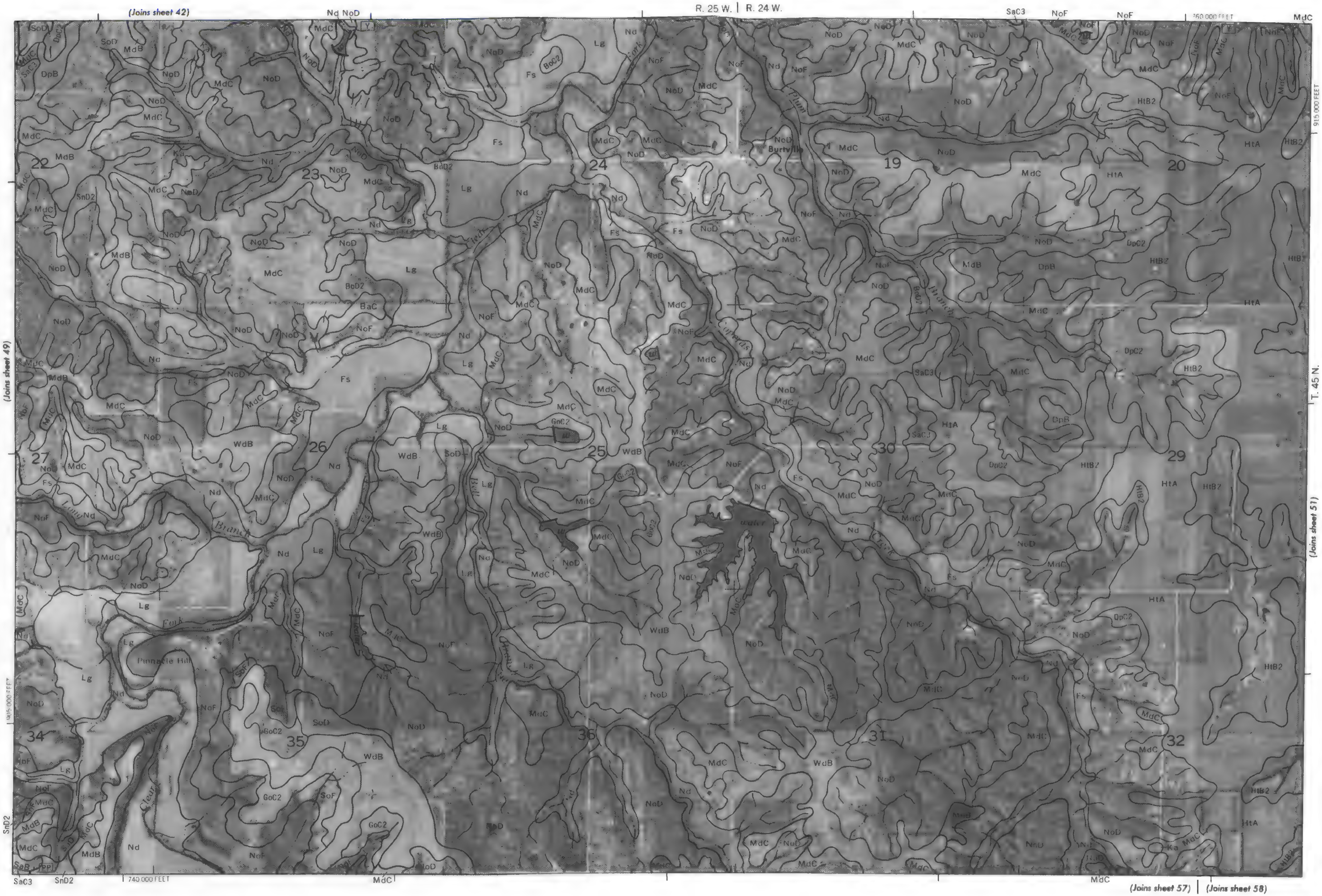



47
N
(Joins sheet 39)
R. 27 W.
R. 26 W
T. 45 N.
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 54)
(Joins sheet 55)
670 000 FEET
1 Mile
5000 Feet
Scale 1:20000
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31


N
(Joins sheet 40)
R. 26 W.
T. 45 N.
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
(Joins sheet 56)
690 000 FEET
905 000 FEET
915 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Post Oak Creek
Brawley Creek
Hogan Fork
East Fork


715 000 FEET
R. 26 W.
R. 25 W.
(Joins sheet 41)
N
915 000 FEET
T. 45 N.
(Joins sheet 48)
(Joins sheet 50)
905 000 FEET
735 000 FEET
(Joins sheet 56)
(Joins sheet 57)
1 Mile
5000 Feet
Scale 1:20000
19
20
21
22
24
25
30
29
28
27
36
31
32
33
34
water

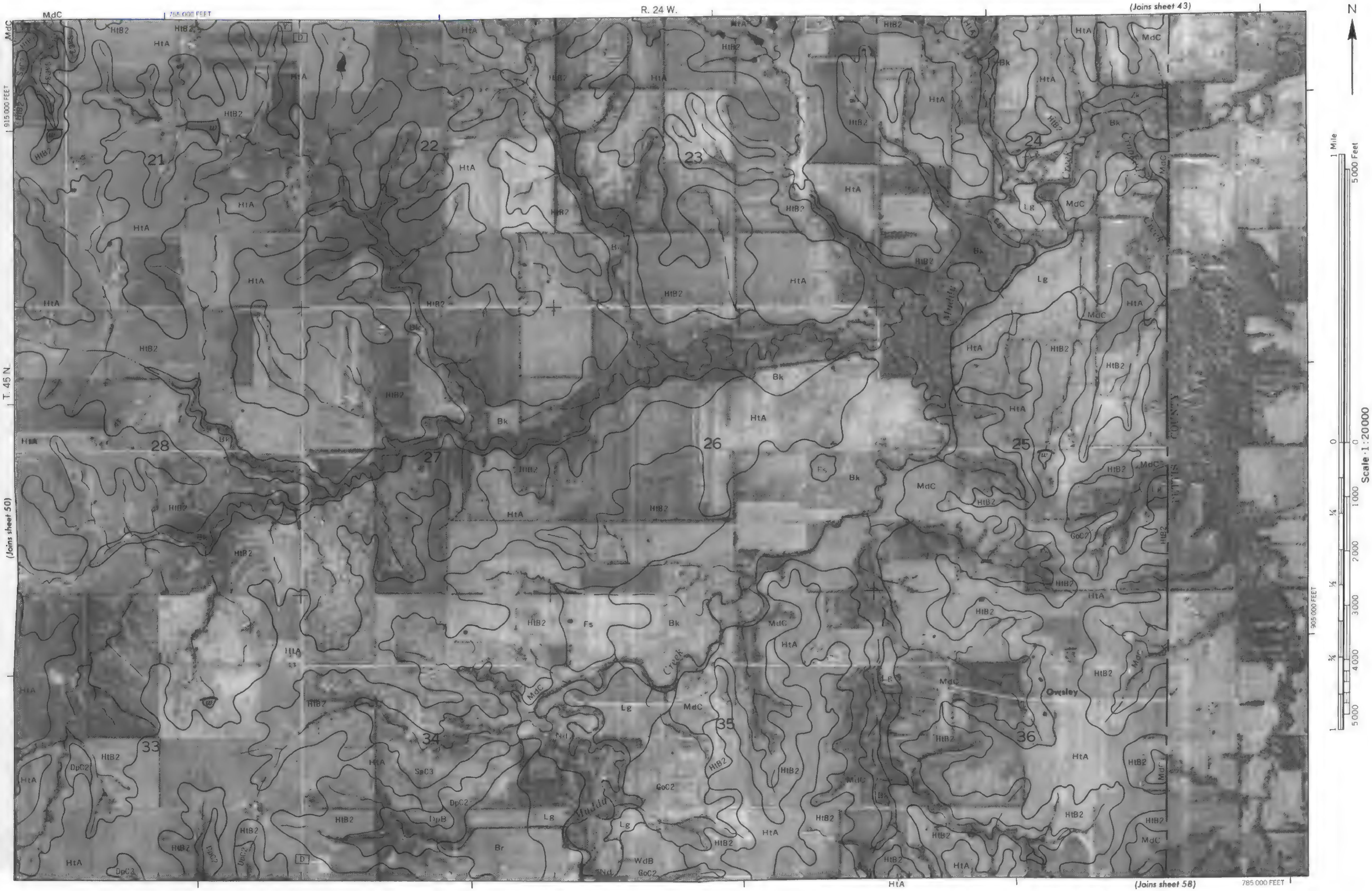
N

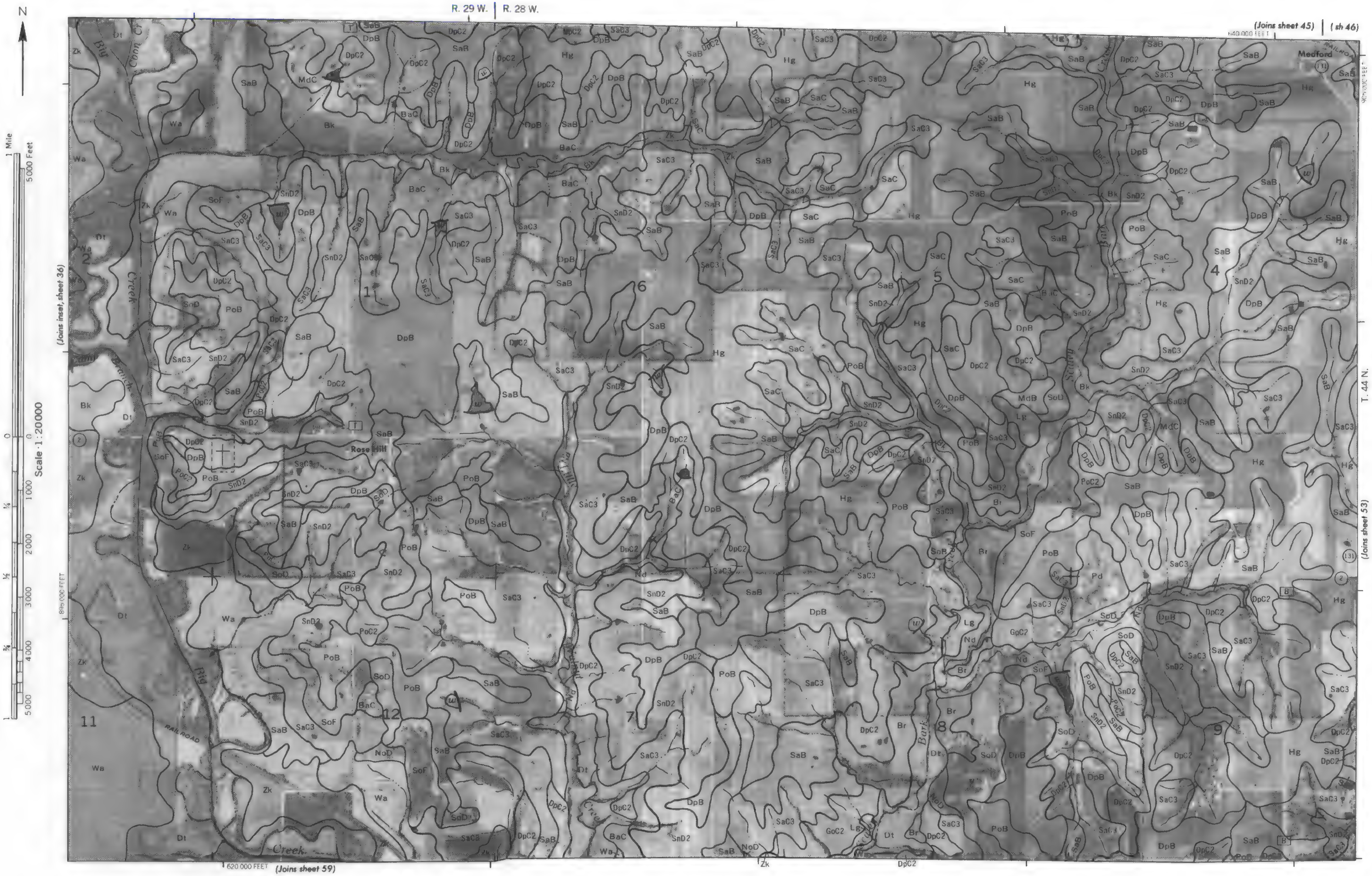


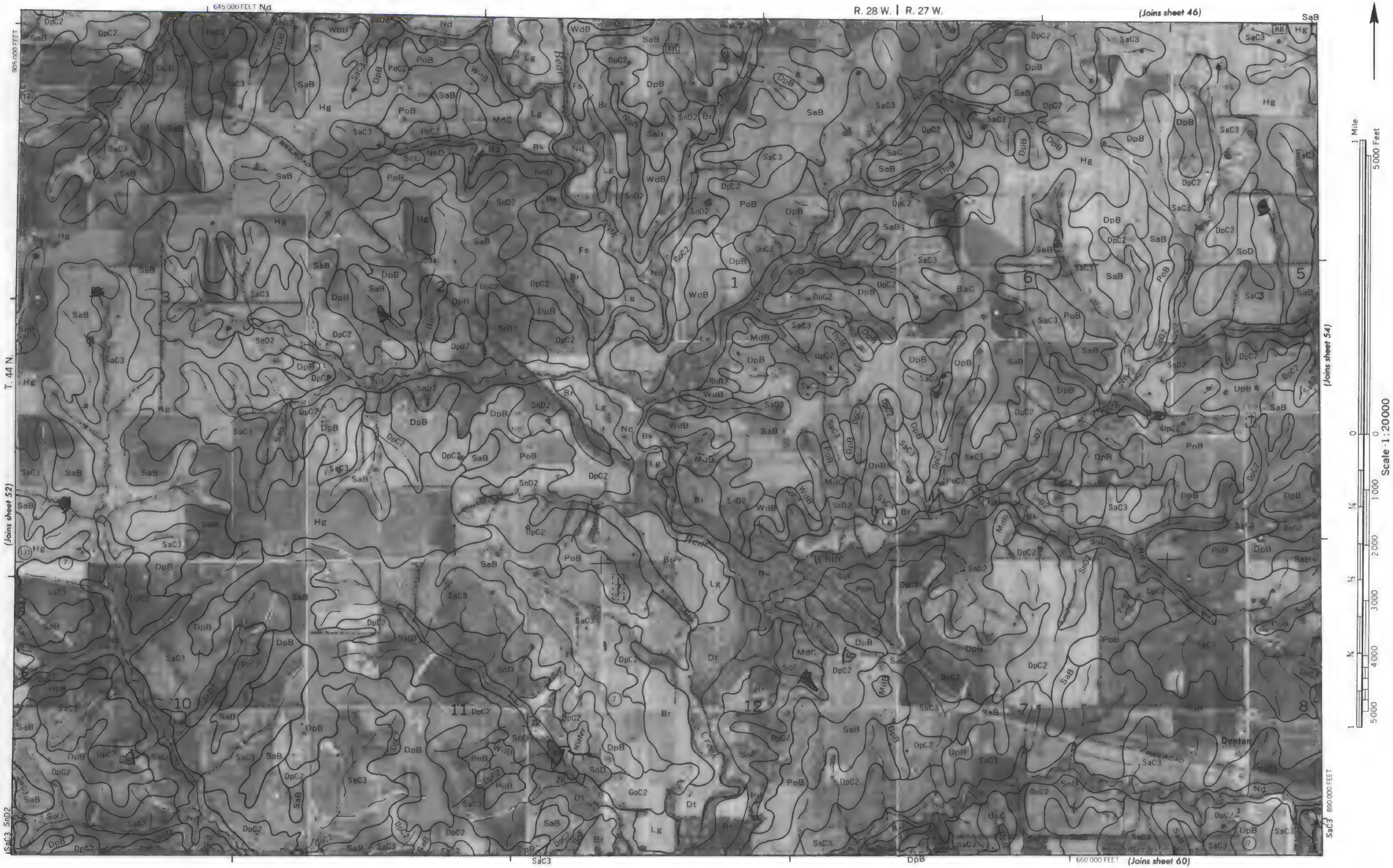
Scale 1:20000

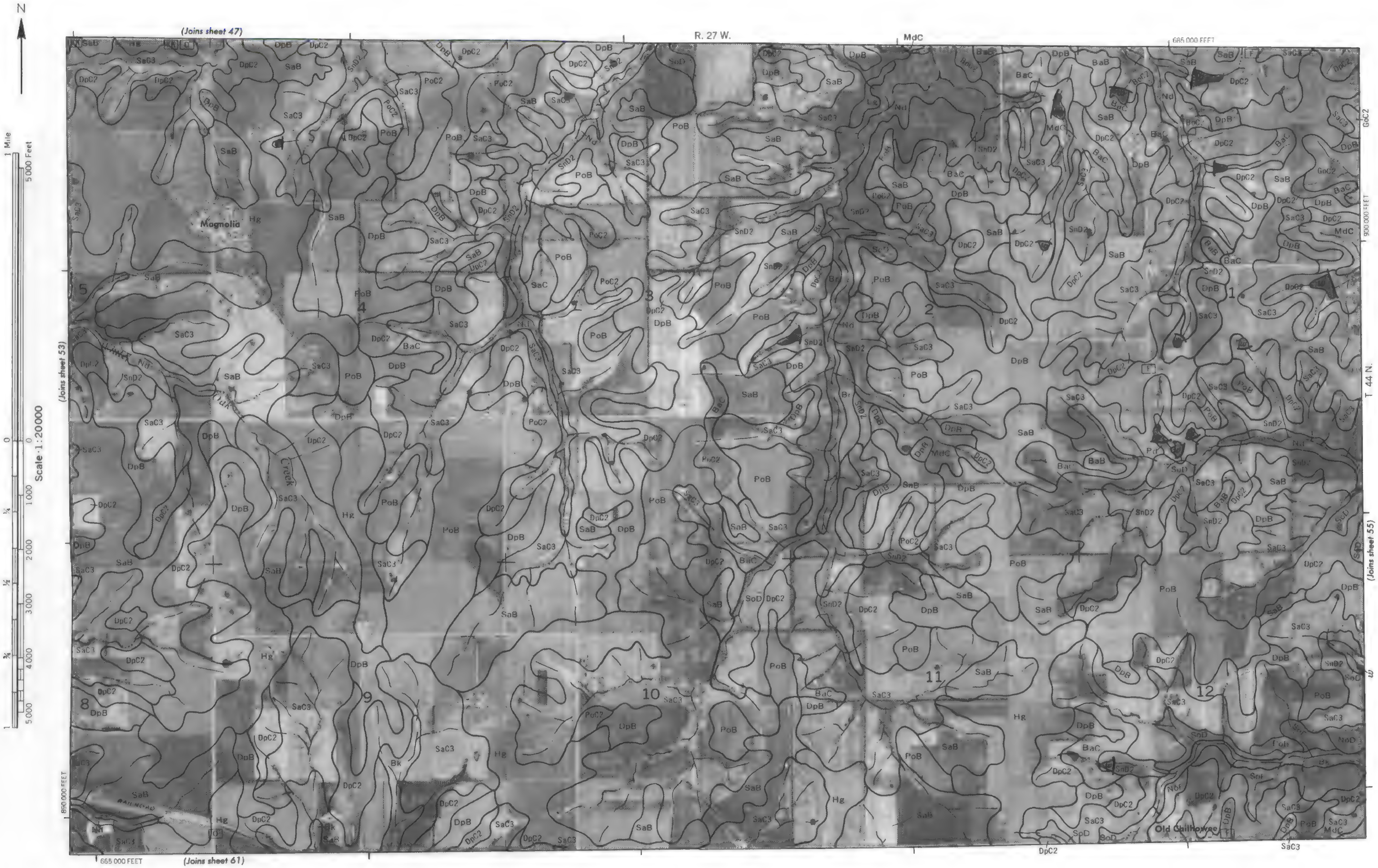
1 Mile

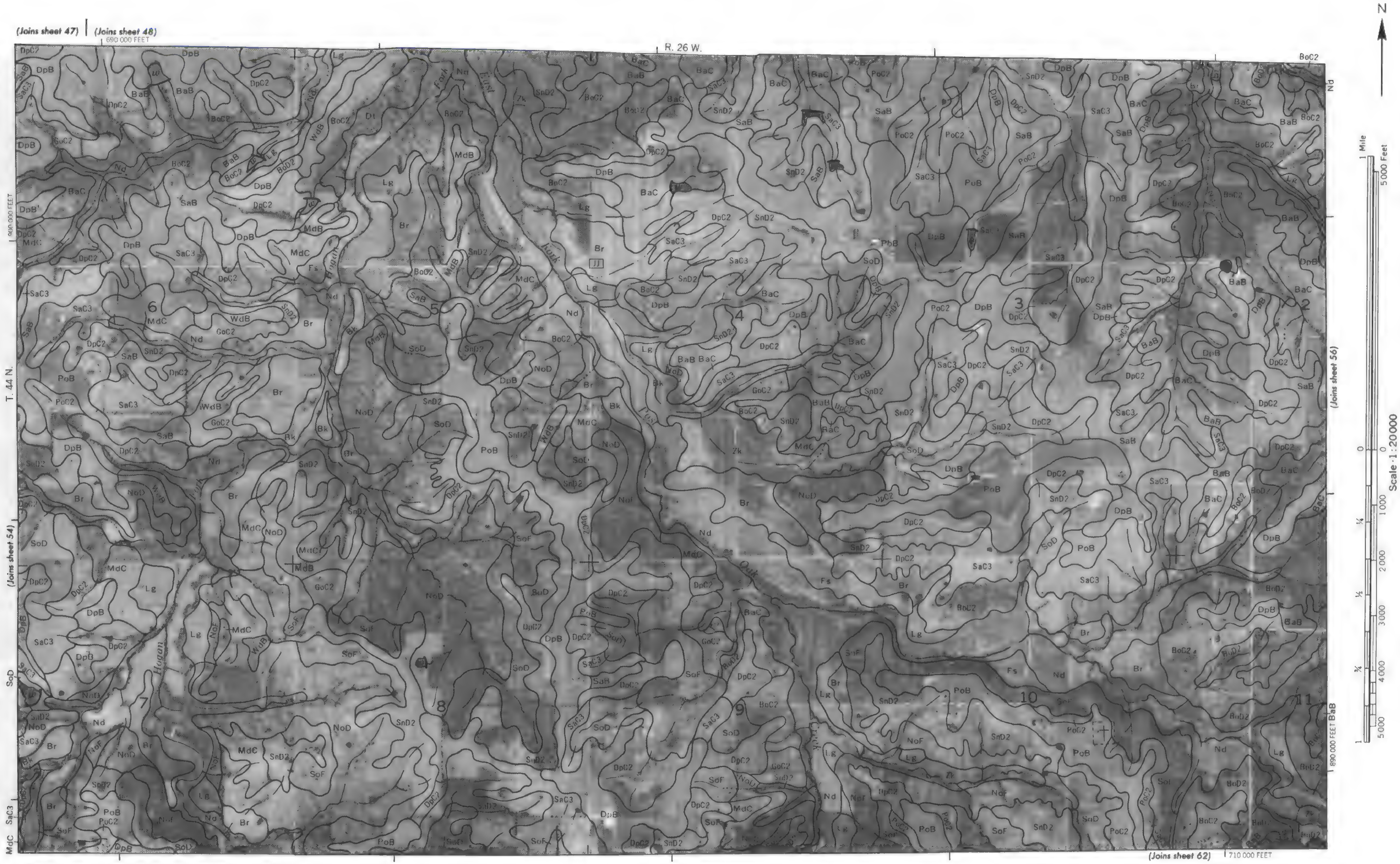
5000 Feet


R. 24 W.
(Joins sheet 43)
(Joins sheet 50)
(Joins sheet 58)
T. 45 N.
915 000 FEET
905 000 FEET
785 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
21
22
23
24
25
26
27
28
33
34
35
36
Owsley
Creek
Muddy
HtA
HtB2
MdC
Bk
Lg
Fs
GoC2
DpC2
DpB
SaC3
WdB
Br


N
R. 29 W.
R. 28 W.
(Joins sheet 45)
(sh 46)
(Joins inset, sheet 36)
(Joins sheet 53)
(Joins sheet 59)
T. 44 N.
Medford
Rose Hill
Big Creek
Coon Cr.
Branch
Creek
Bark
RAILROAD
620 000 FEET
Scale 1:20000
1 Mile
5000 Feet


53
N
(Joins sheet 46)
(Joins sheet 54)
(Joins sheet 52)
(Joins sheet 60)
R. 28 W. | R. 27 W.
T. 44 N.
645 000 FEET
650 000 FEET
905 000 FEET
890 000 FEET
1 Mile
5000 Feet
Scale 1:20000
Denton
Railroad

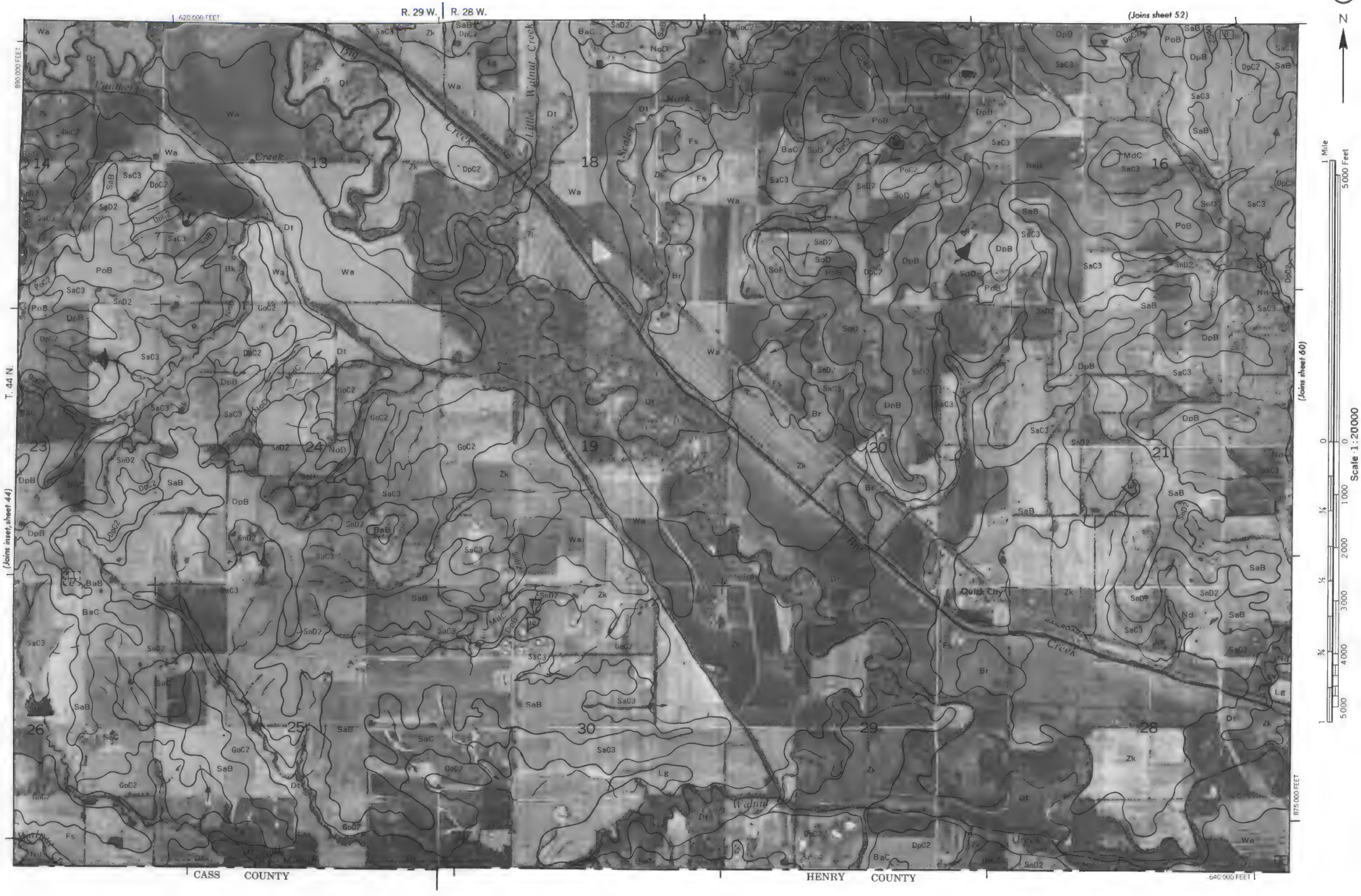

N
(Joins sheet 47)
R. 27 W.
685 000 FEET
(Joins sheet 53)
(Joins sheet 55)
T. 44 N.
930 000 FEET
Magnolia
Old Chilhowee
Scale 1:20000
850 000 FEET
665 000 FEET
(Joins sheet 61)


(Joins sheet 47)
(Joins sheet 48)
690 000 FEET
R. 26 W.
T. 44 N.
890 000 FEET
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 62)
710 000 FEET
890 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000


N
(Joins sheet 48)
(Joins sheet 49)
R. 26 W.
R. 25 W.
735 000 FEET
T. 44 N.
(Joins sheet 57)
715 000 FEET
(Joins sheet 63)
(Joins sheet 55)
1 Mile
5000 Feet
Scale 1:20000

58

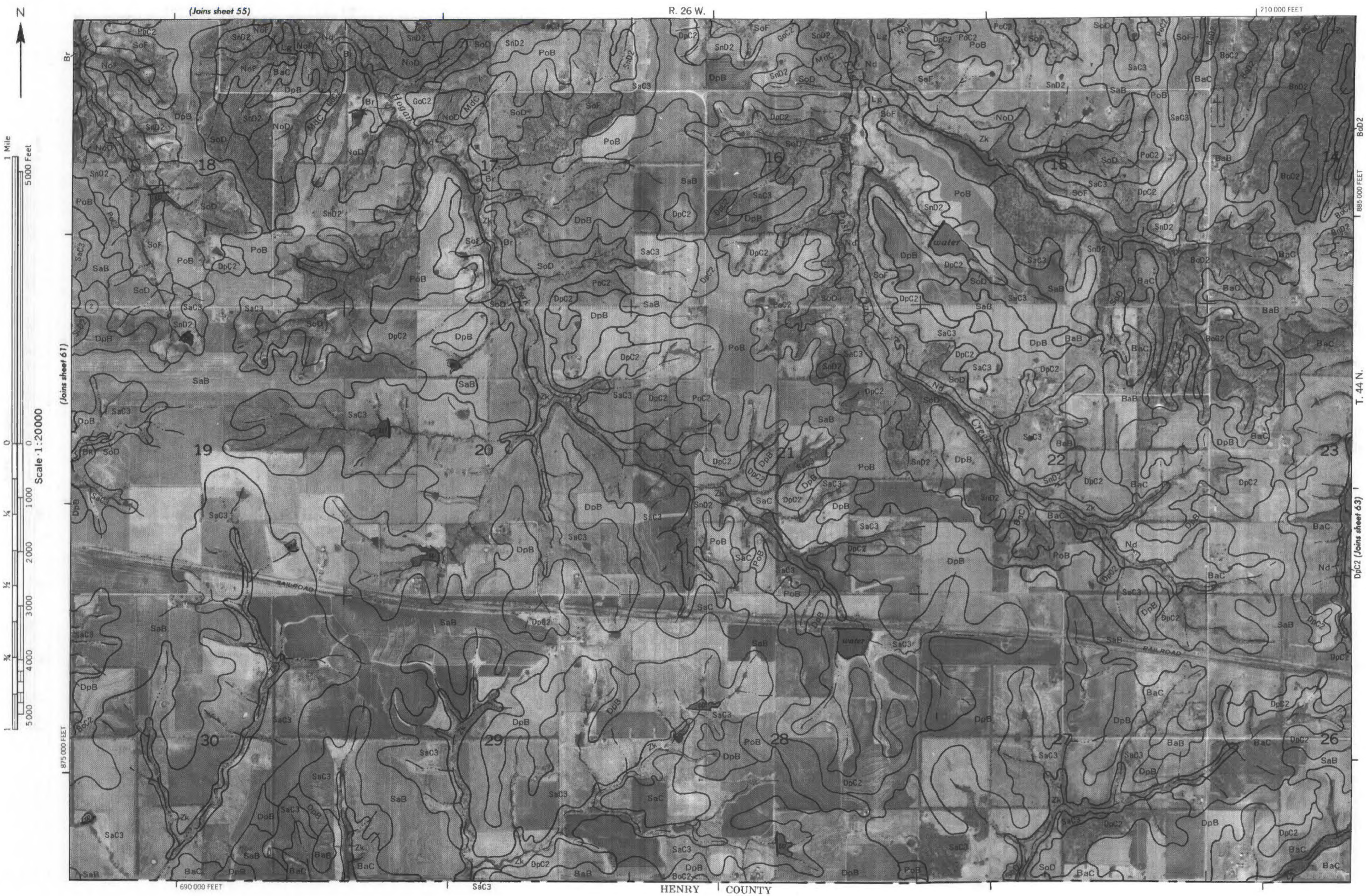

N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 50)
(Joins sheet 51)
R. 24 W.
780 000 FEET
PETTIS CO
T. 44 N.
PETTIS COUNTY
(Joins sheet 57)
760 000 FEET
(Joins sheet 65)


59
N
R. 29 W.
R. 28 W.
(Joins sheet 52)
(Joins sheet 60)
(Joins inset, sheet 44)
T. 44 N.
Scale 1:20000
CASS COUNTY
HENRY COUNTY
Big Creek
Little Walnut Creek
Panther Creek
Mark Sealey
Walnut Creek
Quick City

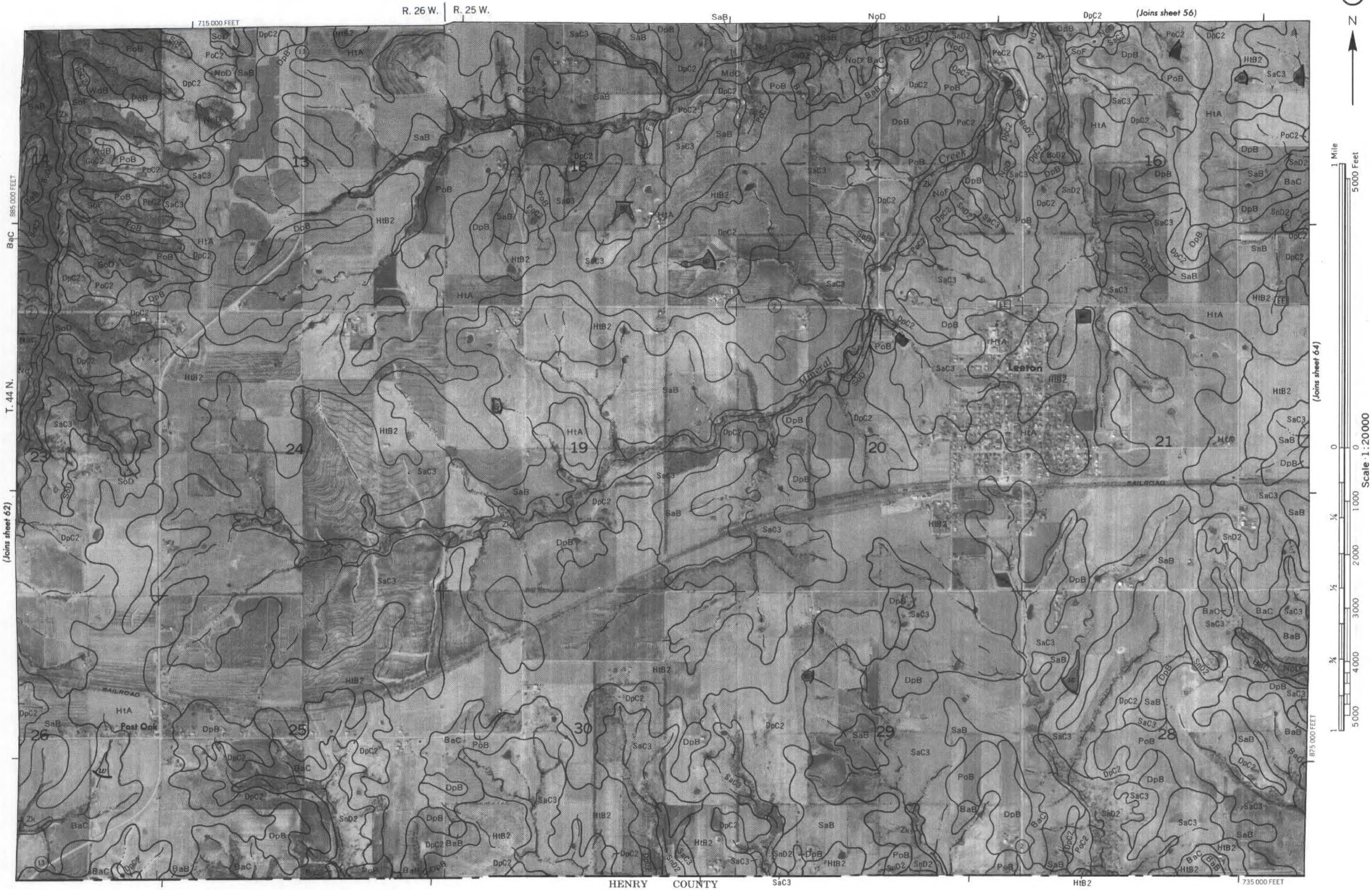
Index Map Welcome Page Manuscript

JOHNSON COUNTY, MISSOURI — SHEET NUMBER 60


61
N
R. 27 W.
(Joins sheet 54)
Old Chilhowee
Chilhowee
RAILROAD
T. 44 N.
(Joins sheet 60)
(Joins sheet 62)
HENRY COUNTY
665 000 FEET
685 000 FEET
13
14
15
16
17
20
21
22
23
24
25
26
27
28
29
1 Mile
5000 Feet
Scale 1:20000


N
(Joins sheet 55)
R. 26 W.
710 000 FEET
885 000 FEET
T. 44 N.
(Joins sheet 61)
(Joins sheet 63)
875 000 FEET
690 000 FEET
HENRY COUNTY
1 Mile
5000 Feet
Scale 1:20000
RAILROAD
Hogan
Fork
Creek
water

JOHNSON COUNTY, MISSOURI — SHEET NUMBER 63



JOHNSON COUNTY, MISSOURI — SHEET NUMBER 64


65
N
760 000 FEET
R. 24 W.
(Joins sheet 58)
885 000 FEET
T. 44 N.
(Joins sheet 64)
Sutherland
Muddy
East Fork Tebo Creek
17
16
15
14
13
20
21
22
23
24
29
28
27
26
25
PETTIS COUNTY
HENRY COUNTY
875 000 FEET
780 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000